# CHAPTER 1 [CE]
# SCOPE AND ADMINISTRATION

(Chapter 1 consists entirely of Seattle amendments and is not underlined)

## SECTION C101
## SCOPE AND GENERAL REQUIREMENTS

**C101.1 Title.** This code, consisting of Chapter 1 [CE] through Chapter 6 [CE] and Appendices A through D, shall be known as the "Seattle Commercial Energy Code," and shall be cited as such. It is referred to herein as "this code."

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

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

**C101.3 Intent.** This code shall regulate the design and construction of buildings for the use and conservation of energy and the reduction of carbon emissions over the life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

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

**C101.4.1 Mixed residential and commercial buildings.** Where a building includes both *residential building* and *commercial building* portions, each portion shall be separately considered and meet the applicable provisions of the Seattle Energy Code—Commercial Provisions or the Seattle Energy Code—Residential Provisions.

**C101.5 Compliance.** *Residential buildings* shall meet the provisions of the Seattle Energy Code—Residential Provisions. *Commercial buildings* shall meet the provisions of the Seattle Energy Code—Commercial Provisions.

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

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

**C101.7 Vesting of initial tenant improvements.** The initial tenant improvements of spaces within a building are permitted to comply with the codes applicable to the base building, if the permit applications are submitted within the 18-month timeframe specified in Section 101.3.2 of the Seattle Building Code.

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

**C102.1 General.** The provisions of this code do not prevent the installation of any material, or prohibit any design or method of construction prohibited by this code or not specifically allowed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *code official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Where the alternative material, design or method of construction is not approved, the *code official* shall respond in writing, stating the reasons why the alternative was not approved.

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 building 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

**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.

**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:

1. Insulation materials and their *R*-values.
2. Fenestration *U*-factors and SHGCs.
3. Area-weighted *U*-factor and SHGC calculations.
4. Mechanical system design criteria.
5. Mechanical and service water heating system and equipment types, sizes and efficiencies.
6. Economizer description.
7. Equipment and systems controls.
8. Fan motor horsepower (hp) and controls.
9. Duct sealing, duct and pipe insulation and location.
10. Lighting fixture schedule with wattage and control narrative.
11. Location of *daylight zones* on floor plan.
12. *Air barrier* details including all *air barrier* boundaries and associated square foot calculations on all six sides of the *air barrier* as applicable.
13. Applicable code edition and date of building permit application.
14. Energy code compliance pathway selected according to Section C401.2.
15. For projects complying with the Prescriptive Path in accordance with Section C401.2, Item 1, a list of all the selected additional energy credits and load management measure credits, to be shown on architectural permit documents, plus applicable additional energy credits and load management measure credits on mechanical, plumbing, boiler, electrical and lighting permit documents.

**C103.2.2 Building thermal envelope depiction.** The building's thermal envelope shall be represented on the construction documents.

**C103.2.3 Document retention.** One set of reviewed and *approved* construction documents 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—C103.5 (Reserved)**

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

**C103.6.1 Record documents.** Construction documents shall be updated by the installing contractor and architect or engineer of record to convey a record of the completed work. Such updates shall include building envelope, mechanical, plumbing, electrical and control drawings red-lined, or redrawn, that show all changes to size, type and locations of components, equipment and assemblies. Record documents shall include the location and model number of each piece of

equipment as installed. The architect, engineer of record or installing contractor is required to provide consolidated record drawings in compliance with this section to the building owner or owner's authorized agent with the timeline specified in Section C103.6.

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

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

1. Submittal data indicating all selected options for each piece of equipment and control device.
2. Manufacturer's operation manuals and maintenance manuals for each device, piece of equipment, and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions, cleaning and recommended relamping shall be clearly identified.
3. Name and address of at least one service agency.
4. Controls system inspection schedule, maintenance and calibration information, wiring diagrams, schematics, and control sequence descriptions. A schedule for inspecting and recalibrating all lighting controls. Desired or field-determined set points shall be PERMANENTLY recorded on control drawings at control devices or, for digital control systems, on the graphic where settings may be changed.
5. A narrative of how each system is intended to operate, including recommended set points. Sequence of operation alone is not acceptable for this requirement.

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

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

1. The envelope insulation compliance path (prescriptive or component performance).
2. All required completed code compliance forms, and all required compliance calculations

For projects complying with Section C402.2, item 2, the documentation shall include:

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

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

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

## SECTION C104
## INSPECTIONS

**C104.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official*, his or her designated agent, or an *approved* agency, in accordance with this section and the International Building Code, International Mechanical Code and Seattle Electrical Code, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building component required to allow inspection to validate compliance with this code.

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

**C104.2.1 Footing and foundation insulation.** Inspections shall verify footing and/or foundation insulation *R*-value, location, thickness, depth of burial and protection of insulation as required by the code, *approved* plans and specifications.

**C104.2.2 Thermal envelope.** Inspections shall be made before application of interior finish and shall verify that envelope components with the correct type of insulation, the R-values, the correct location of insulation, the correct fenestration, the U-factor, SHGC, VT, and air leakage controls are properly installed as required by the code, *approved* plans and specifications, including envelope components in future tenant spaces of multi-tenant buildings.

**C104.2.3 Plumbing system.** Inspections shall verify the type of insulation, the R-values, the protection required, controls, and heat traps as required by the code, *approved* plans and specifications.

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

**C104.2.5 Electrical system.** Inspections shall verify lighting system controls, components, meters; motors and installation of an electric meter for each *dwelling unit* as required by the code, approved plans and specifications.

**C104.2.6 Final inspection.** The final inspection shall include verification of the installation and proper operation of all required building controls, and documentation verifying activities associated with required *building commissioning* have been conducted in accordance with Section C408.

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

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

**C104.5 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

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

## SECTION C105
## VALIDITY

**C105.1 General.** If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder 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 6, 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.

**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.

**C106.2 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

**C106.3 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law. In the case of conflict between the duct sealing and insulation requirements of this code and the requirements of Sections 603 and 604 of the *International Mechanical Code*, the requirements of this 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.

## SECTION C108
## 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.

## SECTION C109
## ADMINISTRATIVE REVIEW

**C109.1 Administrative review by the *code official*.** Prior to issuance of the building permit, 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.** After administrative review and review by the *code official*, and prior to issuance of the building permit, 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*.

## 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 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.

# 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.

**C201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural includes the singular.

**C201.3 Terms defined in other codes.** Terms that are not defined in this code but are defined in the *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *Uniform Plumbing Code* or the *International Residential Code* shall have the meanings ascribed to them in those codes.

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

**ABOVE-GRADE WALL.** That portion of a wall in the building thermal envelope that is not a below-grade wall. This includes between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts.

**ACCESS (TO).** That which enables a device, appliance or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel or similar obstruction.

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

**AFFORDABLE HOUSING.** Affordable housing for the purposes of this code shall include buildings which; a) receive or have received public funding or an allocation of federal low-income housing tax credits; and b) are subject to a regulatory agreement, covenant, or other legal instrument recorded on the property title, and enforceable by the City of Seattle, Washington State Housing Finance Commission, State of Washington, King County, U.S. Department of Housing and Urban Development, or other similar entity as *approved* by the Seattle Director of Housing, that either:

1) Restricts at least 40 percent of the units to occupancy by households earning no greater than 60 percent of median income, and controls the rents that may be charged, for a minimum period of 40 years; or
2) Restricts initial and subsequent sales of at least 40 percent of the residential units to households with incomes no greater than 80 percent of median income, for a minimum period of 50 years. The sale price for sales subsequent to the initial sale shall be calculated to allow modest growth in homeowner equity while maintaining long-term affordability for future buyers.

**AIR BARRIER.** One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the *building thermal envelope* and its assemblies.

**AIR CURTAIN.** A device, installed at the building entrance, that generates and discharges a laminar air stream intended to prevent the infiltration of external, unconditioned air into the conditioned spaces, or the loss of interior, conditioned air to the outside.

**ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (AC-OUTPUT UPS).** A combination of convertors, switches and energy storage devices, such as batteries, constituting a power system for maintaining continuity of load power in case of input power failure. Input power failure occurs when voltage and frequency are outside rated steady state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the uninterruptible power supply. An *AC-output UPC* is an uninterruptible power supply that supplies power with a continuous flow of electric charge that periodically reverses direction.

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

**APPROVED.** Acceptable to the *code official*.

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

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

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

**AUTOMATIC CONTROL DEVICE.** A device capable of automatically controlling equipment and devices without manual intervention.

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

**BEST EFFICIENCY POINT (BEP).** The pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.

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

**BIOMASS.** Nonfossilized and biodegradable organic material originating from plants, animals and/or micro-organisms, including products, byproducts, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.

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

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

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

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

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

**BUILDING COMMISSIONING.** A process that verifies and documents that the building systems have been installed and function according to the approved construction documents.

**BUILDING ENTRANCE.** Any doorway, set of doors, revolving door, vestibule or other form of portal (including elevator doors such as in parking garages) that is ordinarily used to gain access to the building or to exit from the building by its users and occupants. This does not include doors solely used to directly enter mechanical, electrical and other building utility service equipment rooms, or doors for emergency egress only. Where buildings have separate one-way doors to enter or leave, any doors ordinarily used to leave the building are also deemed a building entrance.

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

**BUILDING THERMAL ENVELOPE.** The *below-grade walls*, *above-grade walls*, floors, ceilings, roofs, and any other building element assemblies that meet one or more of the following criteria:

1. Separates conditioned areas of all types from unconditioned or unenclosed areas.
2. Separates conditioned areas of differing types including elements between fully conditioned areas, low energy, semi-heated, greenhouse, and refrigerated areas.

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

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

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

**CEILING FAN.** A nonportable device suspended from a ceiling or overhead structure for circulating air via the rotation of the blades. See also **LARGE-DIAMETER CEILING FAN**.

**CERTIFIED COMMISSIONING PROFESSIONAL.** An individual who is certified by an ANSI/ISO/IEC 17024:2012 accredited organization to lead, plan, coordinate and manage commissioning teams and implement the commissioning process.

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

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

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

**CLEAN WATER PUMP.** A device that is designed for use in pumping water with a maximum nonabsorbent free solid content of 0.016 lb/ft$^3$ (0.256 kg/m$^3$) and with a maximum dissolved solid content of 3.1 lb/ft$^3$ (49.66 kg/m$^3$), provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14°F (-10°C).

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

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

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

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

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

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

**COMMUNITY RENEWABLE ENERGY SYSTEM.** An off-site renewable energy system for which the owner has purchased or leased renewable energy capacity along with other subscribers.

**COMPRESSED AIR SYSTEM.** A system of at least one compressor providing compressed air at 40 psig or higher.

**COMPUTER ROOM.** A room whose primary function is to house equipment for the processing and storage of electronic data and that has a design total *information technology equipment (ITE)* equipment power density less than or equal to 20 watts per square foot (215 watts per m$^2$) of conditioned floor area or a design *ITE* equipment load less than or equal to 10 kW. See also **DATA CENTER**.

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

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

**CONDITIONED SPACE.** An area, room or space that is enclosed within the building thermal envelope and that is directly heated or cooled or that is indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling. Elevator shafts, stair enclosures, enclosed corridors connecting *conditioned spaces*, and *enclosed spaces* through which conditioned air is intentionally transferred at a rate exceeding three air changes per hour are considered *conditioned spaces* for the purposes of the *building thermal envelope* requirements.

**CONTINUOUS INSULATION (CI).** Insulating material that is continuous across all structural members without metal thermal bridges other than fasteners that have a total cross-sectional area not greater than 0.04 percent (0.12 percent where all metal thermal bridges are stainless steel) of the envelope surface through which they penetrate, and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope.

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

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

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

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

**DATA CENTER.** A room or series of rooms that share *data center systems* whose primary function is to house equipment for the processing and storage of electronic data, which has a design total *information technology equipment (ITE)* power density exceeding 20 watts per square foot (215 watts per $m^2$) of conditioned area and a total design *ITE* equipment load greater than 10 kW.

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

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

**DAYLIGHT ZONE.** The portion of the building interior floor area that is illuminated by natural daylight through sidelit and toplit fenestration.

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

**DEDICATED OUTDOOR AIR SYSTEM (DOAS).** A ventilation system that supplies 100 percent outdoor air primarily for the purpose of ventilation without requiring operation of a space-conditioning system fan for outdoor air delivery.

**DEMAND CONTROL KITCHEN VENTILATION (DCKV).** A system that provides automatic, continuous control over exhaust hood, where required, and make-up air fan speed in response to one or more sensors that monitor cooking activity or through direct communication with cooking appliances.

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

**DEMAND RECIRCULATION WATER SYSTEM.** A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe.

**DEMAND RESPONSE SIGNAL.** A signal that indicates a price or a request to modify electricity consumption for a limited time period.

**DEMAND RESPONSIVE CONTROL.** A control capable of receiving and automatically responding to a *demand response signal*.

**DESICCANT DEHUMIDIFICATION SYSTEM.** A mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.

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

**DIRECTLY OWNED OFF-SITE RENEWABLE ENERGY SYSTEM.** An off-site renewable energy system owned by the building project owner.

**DISTRICT ENERGY EFFICIENCY FACTOR.** Ratio of site energy input at the district plant required to produce a unit of heating or cooling at the project site on an annual basis, supported by calculations approved by the code official.

**DOOR, GARAGE.** Nonswinging doors rated by DASMA 105 with a single panel or horizontally hinged sectional panels.

**DOOR, NONSWINGING.** Roll-up, tilt-up, metal coiling and sliding doors, access hatches, and all other doors that are not swinging doors or garage doors with less than or equal to 14 percent glazing.

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

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

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

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

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

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

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

1. Group R-1.
2. Group R-2 where located more than three stories in height above grade plane.

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

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

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

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

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

**HIGH-END TRIM.** A lighting control setting which limits the maximum power to individual luminaires or groups of luminaires in a space.

**HIGH SPEED DOOR.** A nonswinging door used primarily to facilitate vehicular access or material transportation, with a minimum opening rate of 32 inches (813 mm) per second, a minimum closing rate of 24 inches (610 mm) per second and that includes an automatic-closing device.

**HISTORIC BUILDINGS.** ((~~Buildings that are listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law. Any building or structure that is one or more of the following:~~

1. ~~Listed, or certified as eligible for listing, by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.~~
2. ~~Designated as historic under an applicable state or local law.~~
3. ~~Certified as a contributing resource within a National Register-listed, state-designated or locally designated historic district.~~)) See "**LANDMARK**."

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

**HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR).** The ratio of the sum of a building's annual heating and cooling load in thousands of Btus to the sum of annual carbon emissions in pounds from energy consumption of the building HVAC systems. Carbon emissions shall be calculated by multiplying site energy consumption by the carbon emission factors from Table ((~~C407.1~~)) D201.

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

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

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

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

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

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

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

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

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

**INTEGRATED HVAC SYSTEM.** An HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems may include, but are not limited to, HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and stand-alone dehumidifiers modified to allow external heat rejection.

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

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

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

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

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

**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.

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

**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.

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

**LARGEST NET CAPACITY INCREMENT.** The largest increase in capacity when switching between combinations of base compressors that is expected to occur under the *compressed air system* control scheme.

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

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

For multilayer installations, the last rated *R*-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached.

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

**LOW-CARBON DISTRICT ENERGY EXCHANGE SYSTEM.** Any system serving multiple buildings providing energy in the form of a circulated fluid that can accept or reject heat from individual buildings. Energy can be indirectly converted to meet building heating or cooling loads by serving as the heat source or sink for heat-pump systems. Examples include, but are not limited to, low temperature condenser water, ground source condenser water, or sewer heat recovery.

**MECHANICAL LOAD COEFFICIENT (MLC).** In a *data center*, the ratio of the cooling system's net use of energy to that of the *ITE*. The annual MLC is calculated using hourly weather data for the data center's location and equals the sum of all energy flowing into the cooling system to respond to that weather, minus any energy successfully recovered to avoid any new energy use, all divided by the energy flowing into the *ITE* during the same period.

**MECHANICAL ROOM.** A room or space in which mechanical equipment and appliances are located that has sufficient room for access and maintenance of the equipment or appliances with room energy doors closed.

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

1. Is constructed with a metal, structural, weathering surface;
2. Has no ventilated cavity; and
3. Has the insulation entirely below deck (i.e., does not include composite concrete and metal deck construction nor a roof framing system that is separated from the superstructure by a wood substrate) and whose structure consists of one or more of the following configurations:
    a. Metal roofing in direct contact with the steel framing members;
    b. Metal roofing separated from the steel framing members by insulation;
    c. Insulated metal roofing panels installed as described in a or b.

**METAL BUILDING WALL.** ((~~A *wall* whose structure consists of metal spanning members supported by steel structural members (i.e., does not include spandrel glass or metal panels in curtain *wall systems*).~~)) See "Wall, metal building."

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

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

**MULTI-PASS HEAT PUMP WATER HEATER.** A heat pump water heater control strategy requiring multiple passes of water through the heat pump to reach the final target storage water temperature.

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

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

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

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

1. It is designed to withstand full-voltage starting.
2. It develops locked-rotor, breakdown and pull-up torques adequate for general application as specified in Sections 12.38, 12.39 and 12.40 of NEMA MG 1.
3. It draws locked-rotor current not to exceed the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 Hz and paragraph 12.35.2 of NEMA MG 1 for 50 Hz.
4. It has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

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

1. It is designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications up to the values shown in paragraph 12.38.2 of NEMA MG 1 (incorporated by reference; see Sec. 431.15).
2. It has pull-up torque not less than the values shown in paragraph 12.40.2 of NEMA MG 1.
3. It has breakdown torque not less than the values shown in paragraph 12.39.2 of NEMA MG 1.
4. It has a locked-rotor current not to exceed the values shown in paragraph 12.35.1 of NEMA MG 1 for 60 Hz and paragraph 12.35.2 of NEMA MG 1 for 50 Hz.
5. It has a slip at rated load of less than 5 percent.

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

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

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

**OCCUPIED-STANDBY MODE.** Mode of operation when an HVAC zone is scheduled to be occupied and an occupant sensor indicates no occupants are within the zone.

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

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

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

**PHOTOSYNTHETIC PHOTON EFFICACY (PPE).** Photosynthetic photon flux divided by input electric power in units of micromoles per second per watt, or micromoles per joule as defined by ANSI/ASABE S640.

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

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

**PRIMARY STORAGE.** Compressed air storage located upstream of the distribution system and any pressure flow regulators.

**PROCESS APPLICATION.** A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.

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

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

**PUMP ENERGY INDEX (PEI).** The ratio of a pump's energy rating divided by the energy rating of a minimally compliant pump. For pumps with the constant load operating mode, the relevant PEI is $PEI_{CL}$. For pumps with the variable load operating mode, the relevant PEI is $PEI_{VL}$.

**RADIANT HEATING SYSTEM.** A heating system that transfers heat to objects and surfaces within a conditioned space, primarily by infrared radiation.

**READY ACCESS (TO).** That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel or similar obstruction.

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

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

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

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

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

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

**RENEWABLE ENERGY INVESTMENT FUND (REIF).** A fund established by the local government or other entity to accept payment from building owners to construct or acquire qualifying renewable energy (along with the associated RECs) on their behalf.

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

**RENEWABLE POWER PURCHASE AGREEMENT.** A power purchase agreement for off-site renewable energy where the owner agrees to purchase renewable energy output and the associated renewable energy certificates at a fixed price schedule.

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

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

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

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

1. Detached one- and two-family dwellings.
2. Multiple single-family dwellings (townhouses).
3. Group R-3 occupancy areas in buildings three stories or less in height above grade plane whose dwelling units are accessed directly from the exterior.
4. Group R-2 occupancy areas in buildings three stories or less in height above grade plane whose dwelling units are accessed directly from the exterior.
5. Accessory structures to residential buildings.

Group R-2 buildings with dwelling units accessed from interior corridors or other interior spaces are not residential buildings.

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

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

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

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

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

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

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

**SDCI.** The Seattle Department of Construction and Inspections.

**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 an installed heating system output capacity greater than or equal to 3.4 Btu/(h-ft$^2$) but not greater than 8 Btu/(h-ft$^2$). Heating is permitted to be provided by heat pumps complying with the exception to Section C402.1.1.2; and
2. Is not a *walk-in cooler*, *walk-in freezer*, *refrigerated warehouse cooler* or *refrigerated warehouse freezer space*.

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

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

**SIDELIT.** See Section C405.2.5.2.

**SINGLE-PASS HEAT PUMP WATER HEATER.** A heat pump water heater control strategy using variable flow or variable capacity to deliver water from the heat pump at the final target storage water temperature in a single-pass through the heat exchanger with variable incoming water temperatures.

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

**SKYLIGHT.** See "Fenestration."

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

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

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

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

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

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

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

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

**STAND-ALONE DEHUMIDIFIER.** A product with the sole purpose of dehumidifying the space that does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner. Stand-alone dehumidifier is a self-contained, electrically operated, and mechanically encased assembly consisting of:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere;
2. A refrigerating system, including an electric motor;
3. An air-circulating fan; and
4. A means for collecting or disposing of the condensate.

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

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

**STOREFRONT.** A system of doors and windows mulled as a composite fenestration structure that has been designed to resist heavy use. *Storefront* systems include, but are not limited to, exterior fenestration systems that span from the floor level or above to the ceiling of the same story on commercial buildings, with or without mulled windows and doors.

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

**SYSTEM.** A combination of equipment and auxiliary devices (e.g., controls, accessories, interconnecting means and terminal elements) by which energy is transformed so it performs a specific function, such as HVAC, *service water heating* or lighting.

**TEMPERATURE MAINTENANCE.** The system used to maintain the temperature of the building service hot water delivery system, typically by circulation and reheating or by a heat trace system.

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

**TESTING UNIT ENCLOSURE AREA.** The area sum of all the boundary surfaces that define the dwelling unit, sleeping unit, or occupiable conditioned space including top/ceiling, bottom/floor and all side walls. This does not include interior

partition walls within the dwelling unit, sleeping unit, or occupiable conditioned space. Wall height shall be measured from the finished floor of the conditioned space to the finished floor or roof/ceiling air barrier above.

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

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

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

**TOPLIT.** See Section C405.2.5.3.

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

***U*-FACTOR (THERMAL TRANSMITTANCE).** The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h • $ft^2$ • °F) [W/($m^2$ • K)].

**UNCONDITIONED SPACE.** An *enclosed space* within a building that is not a *conditioned space* and that is not categorized under Section C402.1.1. Crawlspaces, attics and parking garages with natural or mechanical *ventilation* are not considered *enclosed spaces*.

**UNHEATED SLAB-ON-GRADE FLOOR.** A slab-on-grade floor that is not a heated slab-on-grade floor.

**UNIFORM ILLUMINATION.** A quality of illumination delivered by a lighting system typically comprised of similar fixtures mounted at a regular spacing interval. This lighting system provides a uniform contrast ratio of no greater than 5:1 maximum-to-minimum ratio throughout the entire area served, including task areas.

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

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

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

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

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

**VISIBLE TRANSMITTANCE – ANNUAL [VT-ANNUAL].** The ratio of visible light entering the space through the fenestration product assembly to the incident visible light during the course of a year, which includes the effects of glazing material, frame, and light well or tubular conduit, and is expressed as a number between 0 and 1. For tubular daylighting devices, VT-annual shall be measured and rated in accordance with NFRC 203.

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

**WALK-IN COOLER.** An enclosed storage space capable of being refrigerated to temperatures above 32°F (0°C) and less than 55°F (12.8°C) that can be walked into, has a ceiling height of not less than 7 feet (2134 mm) and has a total chilled storage area of less than 3,000 square feet (279 $m^2$).

**WALK-IN FREEZER.** An enclosed storage space capable of being refrigerated to temperatures at or below 32°F (0°C) that can be walked into, has a ceiling height of not less than 7 feet (2134 mm) and has a total chilled storage area of less than 3,000 square feet (279 $m^2$).

**WALL.** That portion of the *building envelope*, including opaque area and *fenestration*, that is vertical or tilted at an angle of 60 degrees from horizontal or greater. This includes *above-grade walls* and *below-grade walls*, between-floor spandrels, peripheral edges of floors, foundation *walls*, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof, and skylight shafts.

**WALL, METAL BUILDING.** A *wall* whose structure consists of metal spanning members supported by steel structural members (i.e., does not include spandrel glass or metal panels in curtain *wall systems*).

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

**WALL, WOOD-FRAMED AND OTHER.** All other *wall* types, including wood stud *walls*.

**WATER HEATER.** Any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system.

**WOOD-FRAMED AND OTHER WALLS.** ((~~All other wall types, including wood stud walls.~~)) See "Wall, wood-framed and other."

**ZONE.** A space or group of spaces within a building with heating or cooling requirements that are sufficiently similar so that desired conditions can be maintained throughout using a single controlling device.

# 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).

**TABLE C301.1**
**CLIMATE ZONES, MOISTURE REGIMES, AND**
**WARM-HUMID DESIGNATIONS BY STATE AND COUNTY**

| Key: A – Moist, B – Dry, C – Marine<br>Absence of moisture designation indicates moisture regime is irrelevant | | |
|---|---|---|
| **WASHINGTON** | | |
| 5B Adams | 4C Grays Harbor | 4C Pierce |
| 5B Asotin | 4C Island | 4C San Juan |
| 5B Benton | 4C Jefferson | 4C Skagit |
| 5B Chelan | 4C King | 5B Skamania |
| 4C Clallam | 4C Kitsap | 4C Snohomish |
| 4C Clark | 5B Kittitas | 5B Spokane |
| 5B Columbia | 5B Klickitat | 5B Stevens |
| 4C Cowlitz | 4C Lewis | 4C Thurston |
| 5B Douglas | 5B Lincoln | 4C Wahkiakum |
| 5B Ferry | 4C Mason | 5B Walla Walla |
| 5B Franklin | 5B Okanogan | 4C Whatcom |
| 5B Garfield | 4C Pacific | 5B Whitman |
| 5B Grant | 5B Pend Oreille | 5B Yakima |

## SECTION C302
## DESIGN CONDITIONS

**C302.1 Interior design conditions.** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

**C302.2 Exterior design conditions.** The heating or cooling outdoor design temperatures shall be ((~~selected from Appendix C~~)) 24°F for heating and 86°F dry bulb and 67°F wet bulb for cooling.

## SECTION C303
## MATERIALS, SYSTEMS AND EQUIPMENT

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

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

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

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

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

**C303.1.3 Fenestration product rating.** *U*-factors of fenestration shall be determined as follows:

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

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

Products lacking such a labeled *U*-factor shall be assigned a default *U*-factor from Table C303.1.3(1), C303.1.3(2) or C303.1.3(4). The solar heat gain coefficient (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and labeled and certified by the manufacturer. Products lacking such a labeled SHGC or VT shall be assigned a default SHGC or VT from Table C303.1.3(3). For tubular daylighting devices, $VT_{annual}$ shall be measured and rated in accordance with NFRC 203.

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

**TABLE C303.1.3(1)**
**DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT *U*-FACTORS**

| FRAME TYPE | Window and Glass Door | | SKYLIGHT |
|---|---|---|---|
| | SINGLE PANE | DOUBLE PANE | |
| Metal | 1.20 | 0.80 | See Table C303.1.3(4) |
| Metal with Thermal Break[a] | 1.10 | 0.65 | |
| Nonmetal or Metal Clad | 0.95 | 0.55 | |
| Glazed Block | 0.60 | | |

[a] Metal Thermal Break = A metal thermal break framed window shall incorporate the following minimum design characteristics:
1) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/$ft^2$/°F;
2) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and
3) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in 1) and 2) above.

**TABLE C303.1.3(2)**
**DEFAULT OPAQUE DOOR *U*-FACTORS**
See Appendix A, Section A107

**TABLE C303.1.3(3)**
**DEFAULT GLAZED FENESTRATION SHGC AND VT**

| | SINGLE GLAZED | | DOUBLE GLAZED | | GLAZED BLOCK |
|---|---|---|---|---|---|
| | Clear | Tinted | Clear | Tinted | |
| SHGC | 0.40 | 0.40 | 0.40 | 0.40 | 0.40 |
| VT | 0.6 | 0.3 | 0.6 | 0.3 | 0.6 |

**TABLE C303.1.3(4)**
**DEFAULT *U*-FACTORS FOR SKYLIGHTS**

| FENESTRATION TYPE | FRAME TYPE | | | |
|---|---|---|---|---|
| | ALUMINUM WITHOUT THERMAL BREAK | ALUMINUM WITH THERMAL BREAK | REINFORCED VINYL/ALUMINUM-CLAD WOOD OR VINYL | WOOD OR VINYL-CLAD WOOD/VINYL WITHOUT REINFORCING |
| Single Glazing | | | | |
| glass | U-1.58 | U-1.51 | U-1.40 | U-1.18 |
| acrylic/polycarb | U-1.52 | U-1.45 | U-1.34 | U-1.11 |
| Double Glazing | | | | |
| air | U-1.05 | U-0.89 | U-0.84 | U-0.67 |
| argon | U-1.02 | U-0.86 | U-0.80 | U-0.64 |
| Double Glazing, *e*=0.20 | | | | |
| air | U-0.96 | U-0.80 | U-0.75 | U-0.59 |
| argon | U-0.91 | U-0.75 | U-0.70 | U-0.54 |
| Double Glazing, *e*=0.10 | | | | |
| air | U-0.94 | U-0.79 | U-0.74 | U-0.58 |
| argon | U-0.89 | U-0.73 | U-0.68 | U-0.52 |
| Double Glazing, *e*=0.05 | | | | |
| air | U-0.93 | U-0.78 | U-0.73 | U-0.56 |
| argon | U-0.87 | U-0.71 | U-0.66 | U-0.50 |
| Triple Glazing | | | | |
| air | U-0.90 | U-0.70 | U-0.67 | U-0.51 |
| argon | U-0.87 | U-0.69 | U-0.64 | U-0.48 |
| Triple Glazing, *e*=0.20 | | | | |
| air | U-0.86 | U-0.68 | U-0.63 | U-0.47 |
| argon | U-0.82 | U-0.63 | U-0.59 | U-0.43 |
| Triple Glazing, *e*=0.20 on 2 surfaces | | | | |
| air | U-0.82 | U-0.64 | U-0.60 | U-0.44 |
| argon | U-0.79 | U-0.60 | U-0.56 | U-0.40 |
| Triple Glazing, *e*=0.10 on 2 surfaces | | | | |
| air | U-0.81 | U-0.62 | U-0.58 | U-0.42 |
| argon | U-0.77 | U-0.58 | U-0.54 | U-0.38 |
| Quadruple Glazing, *e*=0.10 on 2 surfaces | | | | |
| air | U-0.78 | U-0.59 | U-0.55 | U-0.39 |
| argon | U-0.74 | U-0.56 | U-0.52 | U-0.36 |
| krypton | U-0.70 | U-0.52 | U-0.48 | U-0.32 |

**Notes for Table C303.1.3(4)**

1. U-factors are applicable to both glass and plastic, flat and domed units, all spacers and gaps.
2. Emissivities shall be less than or equal to the value specified.
3. Gap fill shall be assumed to be air unless there is a minimum of 90% argon or krypton.
4. Aluminum frame with thermal break is as defined in footnote 1 to Table C303.1.3(1).

**TABLE C303.1.3(5)**
**SMALL BUSINESS COMPLIANCE TABLE**
**DEFAULT *U*-FACTORS FOR VERTICAL FENESTRATION**

| Vertical Fenestration Description | | | | Frame Type | | |
|---|---|---|---|---|---|---|
| Panes | Low-e[1] | Spacer | Fill | Any Frame | Aluminum Thermal Break[2] | Wood/Vinyl/ Fiberglass |
| Double[3] | A | Any | Argon | 0.48 | 0.41 | 0.32 |
| | B | Any | Argon | 0.46 | 0.39 | 0.30 |
| | C | Any | Argon | 0.44 | 0.37 | 0.28 |
| | C | High Performance | Argon | 0.42 | 0.35 | Deemed to comply[5] |
| Triple[4] | A | Any | Air | 0.50 | 0.44 | 0.26 |
| | B | Any | Air | 0.45 | 0.39 | 0.22 |
| | C | Any | Air | 0.41 | 0.34 | 0.20 |
| | Any double low-e | Any | Air | 0.35 | 0.32 | 0.18 |

[1] Low-eA (emissivity) shall be 0.24 to 0.16.
Low-eB (emissivity) shall be 0.15 to 0.08.
Low-eC (emissivity) shall be 0.07 or less.

[2] Aluminum Thermal Break = An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/ft$^2$/°F;
b) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and
c) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in a) and b) above.

[3] A minimum air space of 0.375 inches between panes of glass is required for double glazing.

[4] A minimum air space of 0.25 inches between panes of glass is required for triple glazing.

[5] Deemed to comply glazing shall not be used for performance compliance.

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

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

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

**C303.1.5.1 Window wall application.** Where "window wall" or similar assembly that is discontinuous at intermediate slab edges is used, the slab edge *U*-value shall be as listed in Appendix Table ((~~A103.3.7.1(3)~~)) A103.3.7.2 or as determined using an approved calculation.

**C303.1.5.2 Table value assumptions.** In addition to the spandrel panel assembly, the construction assembly *U*-factors assume an air gap between the spandrel panel (with an *R*-value of 1.39) and one layer of 5/8-inch gypsum board (with an *R*-value of 0.56) that provides the interior finish. The gypsum board is assumed to span between the window sill and a channel at the floor. For assemblies that differ from these assumptions, custom *U*-factors can be calculated to account for any amount of continuous insulation or for unusual construction assemblies using Equations 3-1, 3-2 or 3-3 where appropriate. Spandrel panel *U*-factors for assemblies other than those covered by Table C303.1.5 or Equations 3-1 through 3-3 may be determined using an alternate approved methodology. Equations 3-1 through 3-3 do not calculate the value of any insulation inboard of the curtain wall assembly.

**Aluminum without Thermal Break**
**(Equation 3-1)**

$$U_{overall} = \left[\frac{1}{(R_{gypsum} + R_{airgap}) + \left[\frac{1}{0.2798 + \left(\frac{0.8929}{R_{addedinsulation} + \left(\frac{1}{U_{centerofglass}}\right)}\right)}\right]}\right]$$

# CHAPTER 4 [CE]
# COMMERCIAL ENERGY EFFICIENCY

## SECTION C401
## GENERAL

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

**C401.2 Application.** Commercial buildings shall comply with the fossil fuel compliance path according to Section C401.3, or with one of the following:

1. Prescriptive ((~~compliance~~)) path. The prescriptive compliance option requires compliance with ((~~Sections C402 through C406, and Sections C408, C409, C410, C411, and C412~~)) all of Chapter 4, other than Sections C401.3, C401.5, and C407.
2. Total building performance path. The total building performance option requires compliance with Section C407.
3. Appendix F is not adopted by The City of Seattle. ((~~adopted by the local jurisdiction, the requirements of Appendix F, Outcome-Based Energy Budget, Sections C408, C409, C410, C411, C412 and any specific sections in Table C407.2 as determined by the local jurisdiction. The Proposed Total UA of the proposed building shall be no more than 20 percent higher than the Allowed Total UA as defined in Section C402.1.5.~~))
4. Target Performance Path. The requirements of Section C401.5.

**C401.2.1 Application to existing buildings.** Additions, alterations, repairs, and changes of space conditioning, occupancy, or use to existing buildings shall comply with Chapter 5.

**C401.2.2 Application to process equipment.** Energy using equipment used by a manufacturing, industrial, or commercial process other than for conditioning spaces or maintaining comfort and amenities for the occupants shall comply with Section C401.3 Item 2, C403.3.2, Tables C403.3.2(1) through (16) inclusive, Sections C403.3.4.1 through C403.3.4.3, C403.7.7, C403.9.2.1, C403.10.3, C403.11.2, C403.11.3, ((~~Table C404.2, and Sections~~)) C404.2, C404.6, C404.13, C405.8, C410, and C412.

**C401.3 Fossil fuel compliance path.** Buildings complying with the fossil fuel compliance path shall comply with the prescriptive compliance path of this code as defined in Item 1 of Section C401.2, and as modified by this Section C401.3.

**C401.3.1 Modification of code requirements.** For use of this compliance path only, the following changes shall be made to this code:

1. Section C403.1.4 – Space heating. Strike the phrase "...or fossil fuel combustion..." from the first sentence of Section C403.1.4.
2. Section C404.2.1 – Service water heating. Revise the first sentence of Section C404.2.1 to read: "Service hot water shall be provided by fossil fuel water heating equipment, electric air-source heat pump water heating equipment, electric resistance water heating equipment, or a combination of these equipment types meeting the requirements of this section."
3. ((~~Section C406.2.5 – Renewable energy. When determining renewable energy credits in Equation 4-17 of Section C406.2.5, strike the phrase "...limited to 50 percent of the required credits in Section C406.1" in the definition of the factor $AEC_{RRa}$~~)) Reserved.
4. Table C406.2(1) – Efficiency measure credits. Use Table C406.2(2) credit values in place of Table C406.2(1) credit values.

**C401.3.2 Fossil fuel equipment.** Fossil fuel combustion appliances are permitted for HVAC heating, and shall comply with the applicable efficiency standards referenced in Section C403.3.3.2. Fossil fuel combustion appliances are permitted for service water heating, and shall comply with applicable efficiency standards referenced in Table C404.2.

**C401.3.3 Additional efficiency credits.** The number of additional efficiency credits required by Table C406.1 shall be increased by the number required in Table C401.3.3, modified as permitted in this section, and is in addition to the energy efficiency credits and load management credits required by Section C406.

**EXCEPTION:** The required number of space heating additional efficiency credits are permitted to be reduced in the following instances:

1. Low energy spaces in accordance with Section C402.1.1.1 and equipment buildings in accordance with Section C402.1.2 that are served by space heating systems shall comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the efficiency credits required for new construction by Table C401.3.3, modified as permitted in this section.

2. Building additions that have less than 1,000 square feet of conditioned floor area and that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the additional efficiency credits required for additions by Table C401.3.3, modified as permitted in this section.
3. Semi-heated spaces in accordance with Section C402.1.1.2 that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the ((~~space heating~~)) additional efficiency credits required by Table C401.3.3, modified as permitted in this section.
4. Unconditioned spaces, open parking garages and ((~~unheated~~)) unconditioned enclosed parking garages are not required to achieve the additional efficiency credits for space heating required by Table C401.3.3.

**TABLE C401.3.3**
**ADDITIONAL CREDITS REQUIRED**

| Measure Title | Applicable Section | R-1 | R-2 | B | E | M | All other |
|---|---|---|---|---|---|---|---|
| New building – Additional efficiency credits required for space heating systems using the fossil fuel pathway | C401.3.3.1 | 7 | 24 | 101 | 38 | 111 | 56 |
| New building – Additional efficiency credits required for service water heating systems using the fossil fuel pathway | C401.3.3.2 | 198 | 212 | 27 | 17 | 79 | 107 |
| Building additions – Additional efficiency credits required for space heating systems using the fossil fuel pathway | C401.3.3.1 | 4 | 12 | 51 | 19 | 56 | 28 |
| Building additions – Additional efficiency credits required for service water heating systems using the fossil fuel pathway | C401.3.3.1 | 99 | 106 | 14 | 9 | 40 | 54 |

**C401.3.3.1 HVAC credit modification.** The number of HVAC heating energy efficiency credits required by Table C401.3.3 is permitted to be decreased according to the following equation:

((~~CR = A x (B - C)/D~~)) CR = A x (C - B)/D

Where:

CR = additional credits required, rounded to the nearest whole number
A = baseline HVAC heating credits from Table C401.3.3
B = installed fossil fuel or electric resistance space heating capacity in kBTU/h of space heating appliances that comply with any of the exceptions to Section C403.1.4
C = total installed fossil fuel or electric resistance space heating capacity in kBTU/h of all HVAC heating appliances
D = total capacity in kBTU/h of all types of space heating appliances

**C401.3.3.2 Service water heating credit modification.** The number of service water heating energy efficiency credits required by Table C401.3.3 is permitted to be decreased according to the following equation:

((~~CR = A x (B - C)/D~~)) CR = A x (C - B)/D

Where:

CR = additional credits required, rounded to the nearest whole number
A = baseline service water heating credits from Table C401.3.3
B = installed service water heating appliances capacity in kBTU/h of service water heating appliances that comply with ((~~any of the~~)) exceptions 1, 2, 5, 7, or 8 to Section C404.2.1
C = total installed fossil fuel or electric resistance service water heating capacity in kBTU/h of all service water heating appliances, except the supplemental capacity permitted by Section C404.2.1.4
D = total capacity in kBTU/h of all types of service water heating appliances, except the supplemental capacity permitted by Section C404.2.1.4

**C401.3.4 Renewable energy credit limit.** No more than 80 percent of the efficiency credits required by Sections C401.3.3.1 and C401.3.3.2 are permitted to be Renewable Energy credits defined in Section C406.2.5.

**C401.3.5 Discrete area-weighted project compliance.** In addition to the area-weighted credit requirements in Section C406.1.2, where a building includes multiple occupancies, the additional required credits per Table C401.3.3 shall be determined separately for each occupancy group. Additional required credits shall be prorated on an area-weighted basis for each occupancy group in the same manner as required project credits per Section C406.1.

1. Where a single space heating or service water heating system serves multiple occupancies, the number of additional required credits shall be prorated on an area-weighted basis for each occupancy served.
2. Additional required credits for envelope systems shall be prorated on an area-weighted basis for all occupancies.
3. Occupancies are permitted to be subdivided into discrete areas, with required and achieved credits for each area prorated on an area-weighted basis as required for the occupancy group.

**C401.3.6 Electrification readiness.** Additionally, the following provisions shall be required for new construction for each fossil fuel space heating or service water heating appliance installed:

1. Provide a spare electrical branch circuit conduit to the location of a future replacement heat pump appliance to support an equivalent heating capacity.
2. Provide spare electrical service entrance conduits for the purpose of upgrading the main electrical service to support all heat pump appliances throughout the building.
3. The main electrical room has sufficient space to accommodate increasing the main electrical service's size to support all heat pump appliances throughout the building.
4. Additional accommodations for the equipment comprised of transformer(s) and other equipment necessary to support an electrical service upgrade. These accommodations shall include adequate space on the site. If the equipment is located in a transformer vault, that vault must include not only the space to support electrical service upgrade but also include accommodations for additional cooling for larger transformer(s).

**C401.4 Thermal envelope certificate.** A permanent thermal envelope certificate shall be completed by an *approved* party. Such certificate shall be posted on a wall in the space where the space conditioning equipment is located, a utility room or other *approved* location. If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label, or other required labels. A copy of the certificate shall also be included in the construction files for the project. The certificate shall include:

1. *R*-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, crawlspace walls and floors, and ducts outside *conditioned spaces*.
2. *U*-factors and *solar heat gain coefficients* (SHGC) of fenestration.
3. Results from any building envelope air leakage testing performed on the building.

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

**C401.5 Target Performance Path.**

**C401.5.1 Scope.** Buildings of the following occupancy types, including their initial tenant improvements, are permitted to conform to the Target Performance Path as described in this section and are not required to comply with Seattle Energy Code requirements other than the mandatory measures listed in Section C401.5.3.

1. Group B office.
2. Group B medical office.
3. Group R-2 multi-family over three stories.
4. Group S-1 & S-2 warehouse (non-refrigerated).
5. Group E school.
6. Group M retail.
7. Group I-2 hospital.
8. Other occupancy type, where specific permission is granted by the *code official*. Any such permission, if granted, shall be made 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, adjusted to recognize the additional stringency of the current energy code.
9. Mixed use: A mixed use building is any building containing more than one of the occupancies listed in 1 through 8 above.

**C401.5.1.1 Increased building performance factor.** Each building conforming to this section is permitted to utilize a building performance factor (BPF) 1.12 times the BPF in Table C407.3(2).

**C401.5.1.2 Site Energy Performance Target.** Each building conforming to this section must demonstrate compliance with the Site energy performance factor per Table C407.3(3) as part of the permit review. Documentation of compliance with Site Energy Performance Target during the performance period is not required.

**C401.5.2.1 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 the *code official* showing daily, monthly and annual totals during the operational energy use demonstration period set forth in Section C401.5.6. Actual *IT energy* shall be adjusted in accordance with Section C401.5.7.

**C401.5.3 Mandatory measures.** Buildings using the Target Performance Path shall:

1. Not exceed the building performance factor (BPF) permitted by Section C401.5.1.1;
2. Not use fossil fuel combustion or electric resistance appliances for purposes of space heating or domestic water heating, except as permitted by the exceptions to Section C403.1.4;
3. Have a building envelope with a Proposed Total UA no greater than the Allowable Total UA as determined by Section C407.3.1; and
4. Comply with the mandatory measures listed in Table C407.2.

**C401.5.4 Energy modeling methodology.** Energy use shall be modeled according to the requirements of Section C407, Total Building Performance:

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 are 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 application documentation required by Section G1.3.2 of ASHRAE 90.1, Appendix G, 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 C401.5.4**
**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 |

**C401.5.5 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 qual-

ified 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).

**C401.5.6 Demonstration of operating energy use.** Metered energy data shall be supplied directly via automated reporting from utilities to the *code official* using Portfolio Manager, and adjusted for the percentage of the *conditioned floor area* intended for occupancy that is occupied during the recording period. While more than 95 percent occupied, the building shall be considered fully occupied. While no less than 85 percent occupied, the building shall operate at or below its assigned building performance factor established in Section C401.5.2 or Item 8 of Section C401.5.1 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 C401.5. The owner shall notify the *code official* when this 12-month period has been successfully completed.

**SDCI Informative Note:** Documentation of compliance with the site energy reduction target in Section C407.3 is not required.

**C401.5.6.1 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 C401.5.6 based on the most recent one-year period and adjusted for the actual occupancy rate during that period.

**C401.5.7 Adjustment for data center energy usage.** Where *data center IT energy* usage 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 C401.5.2.1, 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 C401.5.2.1, that shortfall shall be subtracted from the total allowable energy use.

**C401.5.8 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 C401.5.2, 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.

**C401.5.9 Adjustment for unusually cold years.** If the heating degree days (HDD) recorded by the National Weather Service for the Seattle-Tacoma International Airport exceeds 4,885 HDD for the 12-month demonstration period (4 percent above the average 4,697 HDD at 65°F base), the assigned energy performance target is permitted to be increased by 1 percent for that period.

**C401.5.10 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.

**C401.5.11 Adjustment for commercial kitchens and other large process loads.** Where the building includes a commercial kitchen, commercial laundry, hospital central sterile processing facility, or similar large process load, and where *approved* by the *code official*, the energy use of the process equipment and exhaust fans and relief air fans and air tempering associated with the use of that equipment is permitted to be separately sub-metered and subtracted from the overall building energy usage. Energy use of typical HVAC, lighting, and miscellaneous electrical loads within such spaces shall not be included in this adjustment. An *approved* plan shall be submitted with the permit documents detailing how the sub-metered process load energy will be automatically deducted from the total building energy use and the adjusted total reported to the *code official*.

**C401.5.12 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 C401.5.6. The penalty shall be administered as provided in Section C110, except that the amount of the penalty shall be determined using Table C401.5.13 and not Section C107. 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 *conditioned 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 *conditioned floor area*.
3. A binding pledge that within 3 years of receipt of the Certificate of Occupancy, adjusted as allowed under Section C401.5.6.1, the applicant will comply with the requirements of this section.

3.1. 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 C401.5.6, 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.

**C401.5.13 Procedure for non-compliance.** If the owner fails to provide evidence that the building has operated as required under Section C401.5.6, 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 C401.5.12(3). The fine 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 according to Table C401.5.13.

**Table C401.5.13**
**Financial Security and Energy Efficiency Reimbursements**

| Energy use exceeding target | Amount of fine or draw-down from financial security, per square foot of gross conditioned floor area | Maximum reimbursement per square foot of gross conditioned floor area for work *approved* under Section C401.5.12 |
|---|---|---|
| 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 |

**C401.5.14 Reimbursements.** Where a financial security has been drawn down pursuant to item 1 in Section C401.5.13, or a fine has been levied pursuant to item 2 in Section C401.5.13, 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 C401.5.13. 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 C401.5.13, or a fine has been levied pursuant to item 2 in Section C401.5.13.

## SECTION C402
## BUILDING ENVELOPE REQUIREMENTS

**C402.1 General.** *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis, in accordance with the compliance path described in Item 1 of Section C401.2, shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the R-value based method of Section C402.1.3, the U-, C- and F-factor based method of Section C402.1.4, or the component performance alternative of Section C402.1.5.
2. Fenestration in the building envelope assemblies shall comply with Section C402.4, or the component performance alternative of Section C402.1.5.
3. Air leakage of building envelope assemblies shall comply with Section C402.5.

**SDCI Informative Note:** For the application of the building envelope requirements to elevator shafts and stair enclosures, see the definition of *conditioned space* in Chapter 2 and the exception to Section C402.1.3.

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

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

1. Those that are heated and/or cooled with a peak design rate of energy usage less than 3.4 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. Unstaffed equipment shelters or cabinets used solely for personal wireless service facilities.

**C402.1.1.2 Semi-heated buildings and spaces.** The building envelope of *semi-heated* buildings, or portions thereof, shall comply with the same requirements as that for conditioned spaces in Section C402, except as modified by this section. The total installed output capacity of mechanical space conditioning systems serving a *semi-heated* building or space shall comply with Section C202, except as modified by this section. Building envelope assemblies separating conditioned space from *semi-heated space* shall comply with exterior envelope insulation requirements. *Semi-heated spaces* are not required to comply with the opaque wall insulation provisions of Section ((~~C402.2.3~~)) C402.2.2 for walls that separate *semi-heated* spaces from the exterior or low energy spaces. Fenestration that forms part of the *building thermal envelope* enclosing semi-heated spaces shall comply with Section C402.4. *Semi-heated spaces* shall be calculated separately from other conditioned spaces for compliance purposes.

Opaque walls in *semi-heated* spaces shall be calculated as fully code compliant opaque walls for both the target and proposed for the Target UA calculations for Component Performance compliance per Section C402.1.5, and for the Baseline Building Design for Total Building Performance compliance per Section C407. The capacity of heat trace temperature maintenance systems complying with Section C404.7.2 that are provided for freeze protection of piping and equipment only shall not be included in the total installed output capacity of mechanical space conditioning systems.

**EXCEPTION:** Provided the total installed heating output capacity of mechanical space conditioning does not exceed the criteria for semi-heated space as defined in Section C202, a semi-heated building or space is permitted to comply with this section when served by heat pumps without electric resistance back up and connected to a heating only thermostat.

**SDCI 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 "semiheated" in Chapter 2 are not required to be insulated, but otherwise the thermal envelope of semiheated spaces must meet all requirements for *conditioned space*. Spaces with any mechanical cooling or with more than 8 BTU/h-ft$^2$ heating capacity must meet all the *building thermal envelope* requirements for *conditioned space*.

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

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

   **EXCEPTION:** Low energy greenhouses that comply with Section C402.1.1.1.
2. Interior partition building thermal envelope assemblies that separate the *greenhouse* from conditioned space complying with Sections C402.2, C402.4.3 and C402.4.4.
3. Fenestration assemblies complying with the thermal envelope requirements in Table C402.1.1.3. The *U*-factor for the skylight shall be for the roof assembly or a roof that includes the assembly and an internal curtain system.

   **EXCEPTION:** Unheated *greenhouses*.
4. No mechanical cooling is provided.
5. For heated greenhouses, heating is provided by a radiant heating system, a condensing natural gas-fired or condensing propane-fired heating system, or a heat pump with cooling capacity permanently disabled as preapproved by the jurisdiction.

**Table C402.1.1.3**
**Fenestration Thermal Envelope Maximum Requirements**

| Component | *U*-Factor BTU/h-ft$^2$-°F |
|---|---|
| Skylights | 0.5 |
| Vertical fenestration | 0.6 |

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

1. Are separate buildings with floor area no more than 500 square feet (50 m$^2$).
2. Are intended to house electric equipment with installed equipment power totaling at least 7 watts per square foot (75 W/m$^2$) and not intended for human occupancy.
3. Are served by mechanical cooling and heating systems sized in accordance with Sections C403.1.2 and C403.3.1.
4. Have a heating system capacity not greater than 17,000 Btu/hr (5 kW) and a heating thermostat set point that is restricted to not more than 50°F (10°C).

5. Have an average wall and roof *U*-factor less than 0.200.

**EXCEPTION:** Where the cooling and heating system is a heat pump, the heating capacity is allowed to exceed 17,000 Btu/h provided the heat pump cooling efficiency is at least 15 percent better than the requirements in Tables C403.3.2(2) and C403.3.2(14).

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

1. Are separate from any other conditioned spaces in the building (do not serve or open into any conditioned, semi-heated or indirectly conditioned space).
2. Have heating and/or cooling equipment sized only to serve the expected elevator loads with thermostat setpoints restricted to heating to no higher than 40°F and cooling to no lower than 95°F.
3. Have an area weighted average wall, roof and floor (where applicable) *U*-factor of less than or equal to 0.20. Calculations must include any floor-slab-edges that penetrate the hoistway and thus are considered part of the above-grade walls.

**Table C402.1.3**
**Opaque Thermal Envelope Insulation Component**
**Minimum Requirements, *R-value* Method[a, ((i)) i]**

| CLIMATE ZONE | 5 AND MARINE 4 | |
|---|---|---|
| | All Other | Group R |
| **Roofs** | | |
| Insulation entirely above deck | R-38ci | R-38ci |
| Metal buildings[b] | R-25 + R-22 LS | R-25 + R-22 LS |
| Attic and other | R-49 | R-49 |
| **Walls, Above Grade[i]** | | |
| Mass[h] | ((~~R-9.5cie~~)) 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 |
| Interior: | | |
| R-13 + R-6 ci wood stud, or | | |
| R-13 + R-10 ci metal stud | Exterior: R-16 c.i. | |
| Interior: | | |
| R-13 + R-6 ci wood stud, or | | |
| R-13 + R-10 ci metal stud | | |
| Mass transfer deck slab edge | N/R | N/R |
| Metal buildings | R-13 + R-14ci | R-13 + R-14ci |
| Steel framed | R-13 + R-10ci | R-19 + R-8.5ci |
| Wood framed and other | R-13 + R-7.5ci std or R-20 + R-3.8ci std or R-25 std | R-13 + R-7.5ci std or R-20 + R-3.8ci std or R-25 std |
| **Walls, Below Grade** | | |
| Below-grade wall[d,h] | ((~~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 |
| **Floors** | | |
| Mass[f] | R-30ci | R-30ci |
| Joist/framing | Steel frame: R-38 +R-10 ci Wood frame: R-38 | Steel frame: R-38 +R-10 ci Wood frame: R-38 |
| **Slab-on-Grade Floors** | | |
| Unheated slabs | R-10 for 24" below | R-10 for 24" below |
| Heated slabs | R-10 perimeter & under entire slab | R-10 perimeter & under entire slab |

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

LS = Liner system—A continuous membrane installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the membrane between the purlins.

a Assembly descriptions can be found in Chapter 2 and Appendix A.

b Where using *R*-value compliance method, a thermal spacer block with minimum thickness of 1/2-inch and minimum *R*-value of R-3.5 shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c (Reserved) ((~~**Exception:** Integral insulated concrete block walls complying with ASTM C90 with all cores filled and meeting both of the following: At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation; and~~
~~The building thermal envelope encloses one or more of the following uses: Warehouse (storage and retail), gymnasium, auditorium, church chapel, arena, kennel, manufacturing plant, indoor swimming pool, pump station, water and waste water treatment facility, storage facility, storage area, motor vehicle service facility. Where additional uses not listed (such as office, retail, etc.) are contained within the building, the exterior walls that enclose these areas may not utilize this exception and must comply with the appropriate mass wall R-value from Table C402.1.3/U-factor from Table C402.1.4.~~))

d Where heated slabs are below grade, they shall comply with the insulation requirements for heated slabs.

e (Reserved)

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

1. 35 pounds per square foot of floor surface area; or
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

g Component performance in accordance with Section C402.1.5 shall be required for buildings with a mass transfer deck slab.

h Peripheral edges of intermediate concrete floors are included in the above-grade mass wall category and therefore must be insulated as above-grade mass walls unless they meet the definition of Mass Transfer Deck Slab Edge. The area of the peripheral edges of concrete floors shall be defined as the thickness of the slab multiplied by the perimeter length of the edge condition. See Table A103.3.7.2 for typical default *U*-factors for above-grade slab edges and footnote c for typical conditions of above-grade slab edges.

i Where the total area of through-wall mechanical equipment is greater than 1 percent of the opaque *above-grade wall area*, use of the *R*-value method is not permitted. See Section C402.1.4.3.

j For roof, wall or floor assemblies where the proposed assembly would not be *continuous insulation*, alternate nominal *R*-value compliance options for assemblies with isolated metal fasteners that penetrate otherwise *continuous insulation* are as shown in columns B and C of Table C402.1.3(i):

**Table C402.1.3(i)**
**Continuous Insulation Equivalents**

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

Notes for Table C402.1.3(i)

These alternate nominal *R*-value compliance options are allowed for projects complying with all of the following:

1a. 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%), for use of Column B equivalents, and greater than or equal to 0.008 (0.08%), but less than 0.0012 (0.12%), for use of Column C equivalents.

1b. Where all metal penetrations are stainless steel, Column B is permitted to be used for penetrations greater than 0.12%, but less than 0.24% of opaque surface area, and Column C is permitted to be used for penetrations greater than or equal to 0.24%, but less than 0.48% of opaque surface area.

2. The metal penetrations of otherwise continuous insulation are isolated or discontinuous (e.g., brick ties or other discontinuous metal attachments, offset brackets supporting shelf angles that allow insulation to go between the shelf angle and the primary portions of the wall structure). No continuous metal elements (e.g., metal studs, z-girts, z-channels, shelf angles) penetrate the otherwise continuous portion of the insulation.

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

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

**C402.1.3 Insulation component *R-value*-based method.** *Building thermal envelope* opaque assemblies shall comply with the requirements of Section C402.2 based on the climate zone specified in Chapter 3. For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R-value* basis, the *R-values* for cavity insulation and continuous insulation shall not be less than that specified in Table C402.1.3. Where cavity insulation is installed in multiple layers, the cavity insulation *R*-values shall be summed to determine compliance with the cavity insulation *R*-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation *R*-values shall be summed to determine compliance with the continuous insulation *R*-value requirements. Cavity insulation *R*-values shall not be used to determine compliance with the continuous insulation *R*-value requirements in Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *R*-values from the "Group R" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *R*-values from the "All other" column of Table C402.1.3.

**EXCEPTION:** For stair and elevator shafts that do not comply with Section C402.1.2.1 and that are located within enclosed garages or other enclosed non-conditioned spaces and without conditioned supply air or cooling or heating appliances rated higher than 2 kW in any shaft, walls enclosing the shafts are permitted to be:

1. Concrete or masonry with minimum R-5 *continuous insulation*;
2. Metal studs with R-15 *cavity insulation* and without *continuous insulation*; or
3. Other assemblies with a maximum U-value of 0.120.

Slab floors, intermediate mass floor edges and elevator pits within shafts using this exception are excluded from envelope insulation requirements. Shaft surfaces using this exception shall not be included in the gross exterior wall area for purposes of maximum fenestration area calculations in Section C402.4.1 component performance calculations in Section C402.1.5, or for the total building performance calculation of Section C407.

**C402.1.4 Assembly *U*-factor, *C*-factor, or *F*-factor-based method.** Building thermal envelope opaque assemblies shall meet the requirements of Section C402.2 based on the climate zone specified in Chapter 3. Building thermal envelope opaque assemblies intended to comply on an assembly *U*-, *C*-, or *F*-factor basis shall have a *U*-, *C*-, or *F*-factor not greater than that specified in Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing Group R occupancies shall use the *U*-, *C*-, or *F*-factor from the "Group R" column of Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing occupancies other than Group R shall use the *U*-, *C*-, or *F*-factor from the "All other" column of Table C402.1.4. The *U*-factors for typical construction assemblies are included in Appendix A. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals* using the framing factors listed in Appendix A where applicable and shall include the thermal bridging effects of framing materials.

**C402.1.4.1 Roof/ceiling assembly.** The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.

**C402.1.4.1.1 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.

**C402.1.4.1.2 Joints staggered.** Continuous insulation board shall be installed not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain, or scupper.

**C402.1.4.2 Thermal resistance of cold-formed steel stud walls.** *U*-factors of walls with cold-formed steel studs shall be permitted to be determined either by using the values in Table C402.1.4.2, or in accordance with Equation 4-1:

$$U = 1/[Rs + (ER)] \qquad \textbf{(Equation 4-1)}$$

Where:

Rs = The cumulative *R-value* of the wall components along the path of heat transfer, excluding the cavity insulation and steel studs.

ER = The effective *R-value* of the cavity insulation with steel studs as specified in Table C402.1.4.2.

**C402.1.4.3 Thermal resistance of mechanical equipment penetrations.** When the total area of penetrations from through-wall mechanical equipment or equipment listed in Table C403.3.2(4) exceeds 1 percent of the opaque *above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default *U*-factor of 0.5. Mechanical system ducts and louvers, including those for supply, exhaust and relief, and for condenser air intake and outlet, are not considered to be mechanical equipment for the purposes of this section.

**EXCEPTION:** Where mechanical equipment has been tested in accordance with *approved* testing standards, the mechanical equipment penetration area is permitted to be calculated as a separate wall assembly using the *U*-factor determined by such test.

**Table C402.1.4**
**Opaque Thermal Envelope Requirements[a,f]**

| CLIMATE ZONE | 5 AND MARINE 4 | |
|---|---|---|
| | All Other | Group R |
| **Roofs** | | |
| Insulation entirely above deck | U-0.027 | U-0.027 |
| Metal buildings | ((~~U-0.031~~)) U-0.027 | ((~~U-0.031~~)) U-0.027 |
| Attic and other | U-0.021 | U-0.021 |
| Joist or single rafter | U-0.027 | U-0.027 |
| **Walls, Above Grade[k]** | | |
| Mass[g] | ((~~U-0.104~~[d])) U-0.057 | ((~~U-0.078~~)) U-0.057 |
| Mass transfer deck slab[i] | U-0.20 | U-0.20 |
| Slab penetrating thermal envelope wall[h] | U-0.10 | U-0.10 |
| Metal building | U-0.050 | U-0.050 |
| Steel framed | U-0.055 | U-0.055 |
| Wood framed and other | U-0.051 | U-0.051 |
| **Walls, Below Grade** | | |
| Below-grade wall[b, g] | ((~~Same as above grade~~)) U-0.070 | ((~~Same as above grade~~)) U-0.070 |
| **Floors** | | |
| Mass[e] | U-0.031 | U-0.031 |
| Joist/framing | ((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist | ((~~U-0.029~~)) U-0.029 steel joist U-0.025 wood joist |
| Concrete column or concrete wall penetrating thermal envelope floor[l] | U-0.55 | U-0.55 |
| Concrete slab floor directly above an electrical utility vault | N.R. | N.R. |
| **Slab-on-Grade Floors** | | |
| Unheated slabs | F-0.54 | F-0.54 |
| Heated slabs[c] | F-0.55 | F-0.55 |
| **Opaque Doors** | | |
| Nonswinging door | U-0.31 | U-0.31 |
| Swinging door[h] | U-0.37 | U-0.37 |
| Garage door <14% glazing | U-0.31 | U-0.31 |
| Garage door ≥14% and <50% glazing[i] | U-0.34 | U-0.34 |

a Use of opaque assembly *U*-factors, *C*-factors, and *F*-factors from Appendix A is required unless otherwise allowed by Section C402.1.4.

b (Reserved) ((~~Where heated slabs are below grade, they shall comply with the *F*-factor requirements for heated slabs.~~))

c Heated slab *F*-factors shall be determined specifically for heated slabs. Unheated slab factors shall not be used.

d (Reserved) ((~~**Exception:** Integral insulated concrete block walls complying with ASTM C90 with all cores filled and meeting both of the following: At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation; and The building thermal envelope encloses one or more of the following uses: Warehouse (storage and retail), gymnasium, auditorium, church chapel, arena, kennel, manufacturing plant, indoor swimming pool, pump station, water and waste water treatment facility, storage facility, storage area, motor vehicle service facility. Where additional uses not listed (such as office, retail, etc.) are contained within the building, the exterior walls that enclose these areas may not utilize this exception and must comply with the appropriate mass wall R-value from Table C402.1.3/U-factor from Table C402.1.4.~~))

e "Mass floors" shall include floors weighing not less than:
1. 35 pounds per square foot of floor surface area; or
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

f Opaque assembly *U*-factors based on designs tested in accordance with ASTM C1363 shall be permitted. The *R*-value of continuous insulation shall be permitted to be added or subtracted from the original test design.

g Peripheral edges of intermediate concrete floors are included in the above-grade mass wall category and therefore must be insulated as above-grade mass walls unless they meet the definition of *Mass Transfer Deck Slab*. The area of the peripheral edges of concrete floors shall be defined as the thickness of the slab multiplied by the perimeter length of the edge condition. See Table A103.3.7.2 for typical default *U*-factors for above-grade slab edges and footnote c for typical conditions of above-grade slab edges.

h Swinging door *U*-factors shall be determined in accordance with NFRC-100.

i Garage doors having a single row of *fenestration* shall have an assembly *U*-factor less than or equal to 0.44, provided that the *fenestration* area is not less than 14 percent and not more than 25 percent of the total door area.

j Component performance in accordance with Section C402.1.5 shall be required for buildings with a mass transfer deck slab. A mass transfer deck, due to its configuration, is not insulated. The table value (U-0.20) shall be used as the baseline value for component performance or total building performance path calculations. For the proposed value, the appropriate value from Table ((~~A104.3.7.2~~)) A103.3.7.2 shall be used.

k Through-wall mechanical equipment subject to Section C402.1.4.3 shall be calculated at the U-factor defined in Section C402.1.4.3. The area-weighted U-factor of the wall, including through-wall mechanical equipment, shall not exceed the value in the table.

l Value applies to concrete columns and concrete walls that interrupt mass floor insulation, but not to perimeter walls or columns separating interior conditioned space from exterior space.

**Table C402.1.4.2**
**Effective *R*-values For Steel Stud Wall Assemblies**

| NOMINAL STUD DEPTH (inches) | SPACING OF FRAMING (inches) | CAVITY *R*-VALUE (insulation) | CORRECTION FACTOR (*Fc*) | EFFECTIVE *R*-VALUE (ER) (Cavity *R*-Value × *Fc*) |
|---|---|---|---|---|
| 3-1/2 | 16 | 13 | 0.46 | 5.98 |
| | | 15 | 0.43 | 6.45 |
| 3-1/2 | 24 | 13 | 0.55 | 7.15 |
| | | 15 | 0.52 | 7.80 |
| 6 | 16 | 19 | 0.37 | 7.03 |
| | | 21 | 0.35 | 7.35 |
| 6 | 24 | 19 | 0.45 | 8.55 |
| | | 21 | 0.43 | 9.03 |
| 8 | 16 | 25 | 0.31 | 7.75 |
| | 24 | 25 | 0.38 | 9.50 |

**C402.1.5 Component performance alternative.** Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the *U*-factors and *F*-factors in Table C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1.

For buildings with more than one *space conditioning category*, component performance compliance shall be demonstrated separately for each space conditioning category. Interior partition ceilings, walls, fenestration and floors that separate space conditioning areas shall be applied to the component performance calculations for the space conditioning category with the highest level of space conditioning.

$$\text{Proposed Total UA} \leq \text{Allowable Total UA} \qquad \textbf{(Equation 4-2)}$$

Where:

| | | |
|---|---|---|
| Proposed Total UA | = | UA-glaz-prop + UA sky-prop + UA-opaque-prop + FL-slab-prop |
| Allowable Total UA | = | UA-glaz-allow + UA-glaz-excess + UA sky-allow + UA-sky-excess + UA-opaque-allow + FL-slab-allow |
| UA-glaz-prop | = | Sum of (proposed *U*-value × proposed area) for each distinct vertical fenestration type, up to code maximum area |
| UA-sky-prop | = | Sum of (proposed *U*-value × proposed area) for each distinct skylight type, up to the code maximum area |
| UA-opaque-prop | = | Sum of (proposed *U*-value × proposed area) for each distinct opaque thermal envelope type |
| FL-slab-prop | = | Sum of (proposed *F*-value × proposed length) for each distinct slab on grade perimeter assembly |
| UA-glaz-allow | = | Sum of (code maximum vertical fenestration *U*-value from Table C402.4, or Section C402.4.1.1.2 if applicable, × proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area[1] |
| UA-glaz-excess | = | *U*-value for the proposed wall type from Table C402.4[2] × vertical fenestration area in excess of the code maximum area |
| UA-sky-allow | = | Sum of (code maximum skylight *U*-value from Table C402.4 × proposed area) for each distinct skylight type proposed, not to exceed the code maximum area |
| UA-sky-excess | = | *U*-value for the proposed roof type from Table C402.4[3] × skylight area in excess of the code maximum area |
| UA-opaque-allow | = | Code maximum opaque envelope *U*-value from Table C402.1.4 for each *opaque door*, wall, roof, and floor assembly × proposed area |
| FL-slab-allow | = | Code maximum *F*-value for each slab-on-grade perimeter assembly × proposed length |

Notes:

1 Where multiple vertical fenestration types are proposed and the code maximum area is exceeded, the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed vertical fenestration area of each type.

2 Where multiple wall types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed above grade wall area of each type.
3 Where multiple roof types are proposed the *U*-value shall be the average Table C402.1.4 *U*-value weighted by the proposed roof area of each type.

**C402.1.5.1 Component *U*-factors and *F*-factors.** The *U*-factors and *F*-factors for typical construction assemblies are included in Chapter 3 and Appendix A. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 3 or Appendix A, values shall be calculated in accordance with the ASHRAE *Handbook—Fundamentals*, using the framing factors listed in Appendix A.

For envelope assemblies containing metal framing, the *U*-factor shall be determined by one of the following methods:

1. Results of laboratory measurements according to acceptable methods of test.
2. ASHRAE *Handbook—Fundamentals* where the metal framing is bonded on one or both sides to a metal skin or covering.
3. The zone method as provided in ASHRAE *Handbook—Fundamentals*.
4. Effective framing/cavity *R*-values as provided in Appendix A.

   When return air ceiling plenums are employed, the roof/ceiling assembly shall:

   a. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and
   b. For gross area purposes, be based upon the interior face of the upper plenum surface.
5. Tables in ASHRAE 90.1 Normative Appendix A.
6. Calculation method for steel-framed walls in accordance with Section ((~~C402.1.4.1~~)) C402.1.4.2 and Table ((~~C402.1.4.1~~)) C402.1.4.2.

**C402.1.5.2 SHGC rate calculations.** Fenestration SHGC values for individual components and/or fenestration are permitted to exceed the SHGC values in Table C402.4 and/or the maximum allowable fenestration areas in Section C402.4.1 where the proposed total SHGCxA less than the allowable total SHGCxA as determined by Equation 4-3.

$$\text{Proposed Total SHGCxA} \leq \text{Allowable Total SHGCxA} \qquad \textbf{(Equation 4-3)}$$

Where:

| | | |
|---|---|---|
| Proposed Total SHGCxA | = | SHGCxA-glaz-prop + SHGCxA-sky-prop |
| Allowable Total SHGCxA | = | SHGCxA-glaz-allow + SHGCxA-sky-allow |
| SHGCxA-glaz-prop | = | Sum of (proposed SHGCx proposed area) for each distinct vertical fenestration type |
| SHGCxA-sky-prop | = | Sum of (proposed SHGCx proposed area) for each distinct skylight type |
| SHGCxA-glaz-allow | = | Sum of (code maximum vertical fenestration SHGC from Table C402.4, or Section C402.4.1.3 if applicable, × proposed area) for each distinct vertical fenestration type, not to exceed the code maximum area |
| SHGCxA-sky-allow | = | Sum of (code maximum skylight SHGC from Table C402.4 × proposed area) for each distinct skylight type, not to exceed the code maximum area |

If the proposed vertical fenestration area does not exceed the Vertical Fenestration Area allowed, the target area for each vertical fenestration type shall equal the proposed area. If the proposed vertical fenestration area exceeds the Vertical Fenestration Area allowed, the target area of each vertical fenestration element shall be reduced in the base envelope design by the same percentage and the net area of each above-grade wall type increased proportionately by the same percentage so that the total vertical fenestration area is exactly equal to the Vertical Fenestration Area allowed.

If the proposed skylight area does not exceed the Allowable Skylight Area from Section C402.4.1, the target area shall equal the proposed area. If the proposed skylight area exceeds the Allowable Skylight Area from Section C402.4.1, the area of each skylight element shall be reduced in the base envelope design by the same percentage and the net area of each roof type increased proportionately by the same percentage so that the total skylight area is exactly equal to the allowed percentage per Section C402.3.1 of the gross roof area.

**C402.2 Specific building thermal envelope insulation requirements.** Insulation in building thermal envelope opaque assemblies shall comply with Sections C402.2.1 through ((~~C402.2.8~~)) C402.2.9 and Table C402.1.3.

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

**C402.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly.

**EXCEPTIONS:**

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

**C402.2.1.1 Minimum thickness, lowest point.** The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

**C402.2.1.2 Suspended ceilings.** Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (*R*-value) of roof insulation in roof/ceiling construction.

**C402.2.1.3 Skylight curbs.** Skylight curbs shall be insulated to the level of roofs with insulation entirely above deck or R-5, whichever is less.

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

**C402.2.1.4 Rooftop HVAC equipment curbs.** Structural curbs installed to support rooftop HVAC equipment are allowed to interrupt the above roof insulation. The area under the HVAC equipment inside of the equipment curb shall be insulated to a minimum of R-13 in all locations where there are not roof openings for ductwork. The annular space between the roof opening and the ductwork shall be sealed to maintain the building air barrier. The plan-view area of the HVAC equipment curb shall be excluded from the prescriptive roof insulation requirements or the area-weighted component performance calculations.

**C402.2.2 Above-grade walls.** The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between the framing members and continuously on the walls shall be as specified in Table C402.1.3, based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with Table C402.1.3 except as otherwise noted in the table. In determining compliance with Table C402.1.4, the use of the *U*-factor of concrete masonry units with integral insulation shall be permitted.

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

1. Weigh not less than 35 psf (170 kg/m$^2$) of wall surface area.
2. Weigh not less than 25 psf (120 kg/m$^2$) of wall surface area where the material weight is not more than 120 pounds per cubic foot (pcf) (1,900 kg/m$^3$).
3. Have a heat capacity exceeding 7 Btu/ft$^2$ × °F (144 kJ/m$^2$ × K).
4. Have a heat capacity exceeding 5 Btu/ft$^2$ × °F (103 kJ/m$^2$ × K) where the material weight is not more than 120 pcf (1900 kg/m$^3$).

**C402.2.3 Floors.** The thermal properties (component *R*-values or assembly *U*- or *F*-factors) of floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1.3 or C402.1.4 based on the construction materials used in the floor assembly. Floor framing cavity insulation or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.

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

1. Thirty-five pounds per square foot of floor surface area;
2. Twenty-five pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

**EXCEPTIONS:**

1. The floor framing cavity insulation or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or exceeds the minimum *R*-value in Table C402.1.3 for "Metal framed" or "Wood framed and other" values for "Walls, Above Grade" and extends from the bottom to the top of all perimeter floor framing or floor assembly members.

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

**C402.2.4 Slabs-on-grade.** The minimum thermal resistance (R-value) of the insulation for unheated or heated slab-on-grade floors designed in accordance with the R-value method of Section C402.1.3 shall be as specified in Table C402.1.3.

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

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

**C402.2.5 Below-grade walls.** The *R*-value of the insulating material installed in, or continuously on, the below-grade walls shall be in accordance with Table C402.1.3. The *U*-factor or *R*-value required shall extend to the level of the lowest floor of the conditioned space enclosed by the below-grade wall.

**C402.2.6 Insulation of radiant heating systems.** *Radiant heating system* panels, and their associated components that are installed in interior or exterior assemblies shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.4.

**EXCEPTION:** Heated slabs on grade insulated in accordance with Section C402.2.4.

**C402.2.7 Airspaces.** Where the R-value of an airspace is used for compliance in accordance with Section C401.2, the airspace shall be enclosed in an unventilated cavity constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.

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

**C402.2.8 Above-grade exterior concrete slabs.** Above-grade concrete slabs that penetrate the *building thermal envelope* including, but not limited to, decks and balconies, shall each include a minimum R-10 thermal break, aligned with the primary insulating layer in the adjoining wall assemblies. Stainless steel (but not carbon steel) reinforcing bars are permitted to penetrate the thermal break. If the total building performance path or the component performance alternative in Section C402.1.5 is utilized and the thermal break required by this section is not provided where concrete slabs penetrate the *building thermal envelope*, the sectional area of the penetration shall be assigned the default *U*-factors from the "exposed concrete" row of Table A103.3.7.2.

**EXCEPTION:** *Mass transfer deck slabs*.

**C402.2.9 Vertical fenestration intersection with opaque walls.** *Vertical fenestration* shall comply with Items 1, 2, and 3, as applicable.

1. Where wall assemblies include *continuous insulation*, the exterior glazing layer of *vertical fenestration* and any required thermal break in the frame shall each be aligned within 2 inches laterally of either face of the *continuous insulation* layer.
2. Where wall assemblies do not include *continuous insulation*, the exterior glazing layer of *vertical fenestration* and any required thermal break in the frame shall each be aligned within the thickness of the *wall* insulation layer and not more than 2 inches laterally from the exterior face of the outermost insulation layer.
3. Where the exterior face of the *vertical fenestration* frame does not extend to the exterior face of the opaque wall rough opening, the exposed exterior portion of the rough opening shall be covered with either a material having an *R*-value not less than R-3, or with minimum 1.5-inch thickness wood.

**C402.3 Reserved.**

**C402.4 Fenestration.** Fenestration shall comply with Sections C402.4 through C402.4.4 and Table C402.4. Daylight responsive controls shall comply with this section and Section C405.2.5.

**EXCEPTION:**

1. For prescriptive envelope compliance, single-pane glazing is permitted for security purposes and for revolving doors, not to exceed 1 percent of the gross exterior wall area. Where Section C402.1.5, component performance alternative, is used, the single glazing shall be included in the percentage of the total glazing area, U-factor and SHGC requirements.

**Table C402.4**
**Building Envelope Fenestration Maximum *U*-factor and SHGC Requirements[f]**

| CLIMATE ZONE | 5 AND MARINE 4 | |
|---|---|---|
| | ***U*-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products[a]** | |
| Fixed[b] *U*-factor | U-0.34 | |
| Operable[c] *U*-factor | U-0.36 | |
| ***Entrance doors*[d]** | | |
| *U*-factor | U-0.60 | |
| | ***U*-factor for all other vertical fenestration** | |
| Fixed *U*-factor | U-0.26 | |
| Operable or mulled windows with fixed and operable sections *U*-factor | U-0.28 | |
| **SHGC for all vertical fenestration** | | |
| | Fixed | Operable |
| PF < 0.2 | 0.38 | 0.33 |
| 0.2 ≤ PF < 0.5 | 0.46 | 0.40 |
| PF ≥ 0.5 | 0.61 | 0.53 |
| **Skylights** | | |
| *U*-factor | ((~~U-0.50~~)) U-0.45 | |
| SHGC | ((~~0.35~~)) 0.32 | |

a *U*-factor and SHGC shall be rated in accordance with NFRC 100.
b "Fixed" includes curtain wall, storefront, picture windows, and other fixed windows.
c "Operable" includes openable fenestration products other than "entrance doors," and includes only the operable portions of multi-pane assemblies.
d "Entrance door" includes glazed *swinging* entrance doors and *automatic* glazed sliding *entrance doors*. Other doors which are not entrance doors, including manually operated sliding glass doors, are considered "operable."
e Reserved.
f Fenestration that is entirely within the conditioned space or is between conditioned and other enclosed space is exempt from solar heat gain coefficient requirements and not included in the SHGC calculation.

**SDCI Informative Note:** The category at the top of Table C402.4, labeled "*U-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products*," includes *curtain wall*, storefront, ribbon wall, window wall, and similar site-assembled systems, but does not include typical punched-opening manufactured windows except for "Class AW" windows. Class AW is the AAMA designation for windows typically used in mid-rise and high-rise buildings to resist high wind and water intrusion loads.

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

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

**EXCEPTIONS:**

1. For vertical fenestration at street level retail or for other occupancies where the Seattle Land Use Code requires street-level transparency, the vertical 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 used, 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 vertical fenestration area is permitted to be exceeded, if the additional fenestration area is deducted from fenestration allowances from other areas of the building.

2. Accessory occupancy areas that comprise less than 10 percent of the conditioned floor area of any floor are permitted to be included in the primary occupancy of that floor for determination of the allowable fenestration area for that floor.

**C402.4.1.1 Vertical fenestration maximum area with high performance alternates.** For buildings that comply with Section C402.4.1.1.1 or C402.4.1.1.2, the total building vertical fenestration area is permitted to exceed 30 percent but shall not exceed 40 percent of the total building gross above grade wall area for the purpose of prescriptive compliance with Section C402.1.4.

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

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

1. Not less than 50 percent of the total conditioned floor area in the building is within a *daylight zone* that includes *daylight responsive controls* complying with Section C405.2.5.1.
2. Visible transmittance (VT) of all *vertical fenestration* in the building is greater than or equal to 1.1 times the required solar heat gain coefficient (SHGC) in accordance with Section C402.4, or 0.50, whichever is greater. It shall be permitted to demonstrate compliance based on the area weighted average *VT* being greater than or equal to the area weighted average of the minimum *VT* requirements.

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

**C402.4.1.1.2 High-performance fenestration.** All of the following requirements shall be met:

1. All *vertical fenestration* in the building shall comply with the following *U*-factors:
   - 1.1. *U*-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products (fixed) = 0.31
   - 1.2. *U*-factor for Class AW windows rated in accordance with AAMA/CSA101/I.S.2/A440, vertical curtain walls and site-built fenestration products (operable) = 0.36
   - 1.3. Entrance doors = 0.60
   - 1.4. *U*-factor for all other vertical fenestration, fixed = 0.23
   - 1.5. *U*-factor for all other vertical fenestration, operable, or mulled windows with fixed and operable sections = 0.24
2. The SHGC of the vertical fenestration shall be no more than 0.9 times the maximum SHGC values listed in Table C402.4.

An area-weighted average shall be permitted to satisfy the *U*-factor requirement for each fenestration product category listed in Item 1 of this section. Individual fenestration products from different fenestration product categories shall not be combined in calculating the area-weighted average *U*-factor, except that fenestration from lines ((~~a.~~)) 1.1 and ((~~b.~~)) 1.2 are permitted to be combined, and the fenestration in lines 1.4 and 1.5 are permitted to be combined. Maximum U-factors for skylights, and maximum SHGC values for all fenestration, shall comply with Section C402.4.

**C402.4.2 Minimum skylight fenestration area.** Skylights shall be provided in enclosed spaces that meet all the following criteria:

1. Floor area of enclosed spaces is greater than 2,500 square feet (232 $m^2$).
2. Space is located directly under a roof and have a ceiling height greater than 15 feet (4572 mm) for no less than 75 percent of the ceiling area.
3. Space type is one of the following: Office, lobby, atrium, concourse, corridor, gymnasium/exercise center, convention center, automotive service, manufacturing, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation, and workshop.

Skylights in these spaces are required to provide a total toplit daylight zone area not less than 50 percent of the floor area and shall provide one of the following:

1. A minimum ratio of skylight area to toplit daylight zone area under skylights of not less than 3 percent where all skylights have a VT of at least 0.40, or $VT_{annual}$ of not less than 0.26, as determined in accordance with Section C303.1.3.
2. A minimum skylight effective aperture, determined in accordance with Equation 4-5, of:
   - 2.1. Not less than 1 percent using a skylight's VT rating; or

2.2. Not less than 0.66 percent using a *tubular daylight device's* $VT_{annual}$ rating.

Skylight Effective Aperture = (0.85 × Skylight Area × Skylight VT × WF)/Toplit daylight zone **(Equation 4-5)**

Where:

| | | |
|---|---|---|
| Skylight area | = | Total fenestration area of skylights. |
| Skylight VT | = | Area weighted average visible transmittance of skylights. |
| WF | = | Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 feet (610 mm), or 0.7 if light well depth is 2 feet (610 mm) or greater, or 1.0 for *tubular daylighting devices* (TDD) with $VT_{annual}$ ratings measured in accordance with NFRC 203. |
| Light well depth | = | Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight. |

**EXCEPTIONS:**

1. Skylights above daylight zones of enclosed spaces are not required in:
   1.1. Spaces designed as storm shelters complying with ICC 500.
   1.2. Spaces where the designed *general lighting* power densities are less than 0.5 W/ft$^2$ (5.4 W/m$^2$) and at least 10 percent lower than the lighting power allowance in Section C405.4.2.
   1.3. Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.
   1.4. Spaces where the daylight zone under rooftop monitors is greater than 50 percent of the enclosed space floor area.
   1.5. Spaces where the total floor area minus the sidelit daylight zone area is less than 2,500 square feet (232 m$^2$), and where the lighting in the daylight zone is controlled in accordance with Section ((~~C405.2.3.1~~)) C405.2.4.
2. The skylight effective aperture, calculated in accordance with Equation 4-5, is permitted to be 0.66 percent in lieu of 1 percent if the $VT_{annual}$ of the skylight or *TDD*, as measured by NFRC 203, is greater than 38 percent.

**C402.4.2.1 Lighting controls in daylight zones under skylights.** Daylight responsive controls shall be provided to control all electric lights within toplit daylight zones.

**C402.4.2.2 Haze factor.** Skylights in office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store, and distribution/sorting area spaces shall have a glazing material or diffuser with a haze factor greater than 90 percent when tested in accordance with ASTM D 1003.

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

**C402.4.2.3 Daylight zones.** Daylight zones referenced in Sections C402.4.1.1 through C402.4.2.2 shall comply with Sections C405.2.5.2 and C405.2.5.3, as applicable. Daylight zones shall include toplit daylight zones and sidelit daylight zones.

**C402.4.3 Maximum *U*-factor and SHGC.** The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.4.

The window projection factor shall be determined in accordance with Equation 4-6.

$$PF = A/B \quad \textbf{(Equation 4-6)}$$

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.

**C402.4.3.1 Reserved**

**C402.4.3.2 Reserved.**

**C402.4.3.3 Dynamic glazing.** Where *dynamic glazing* is intended to satisfy the SHGC ((~~and VT~~)) requirements of Table C402.4, the ratio of the higher to lower labeled SHGC shall be greater than or equal to 2.4, and the *dynamic glazing* shall be automatically controlled to modulate the amount of solar gain into the space in multiple steps. *Dynamic glazing* shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not *dynamic glazing* shall not be permitted.

**EXCEPTION:** *Dynamic glazing* is not required to comply with this section where both the lower and higher labeled SHGC already comply with the requirements of Table C402.4.

**C402.4.3.4 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 C402.4. Individual fenestration products from different fenestration product categories listed in Table C402.4 shall not be combined in calculating area-weighted average *U*-factor.

**C402.4.4 Doors.** *Opaque doors* shall be considered part of the gross area of above-grade walls that are part of the building thermal envelope, including the frame. *Opaque doors* shall comply with Table C402.1.4. Other doors shall comply with the provisions of Section C402.4.3 for vertical fenestration.

**C402.5 Air leakage – thermal envelope.** The thermal envelope of buildings shall comply with Sections C402.5.1 through C402.5.8.

**C402.5.1 Air barriers.** A continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be located on the inside or outside of the *building thermal envelope*, located within the assemblies composing the *building thermal envelope*, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1 and C402.5.1.2.

**C402.5.1.1 Air barrier construction.** The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect, and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.8. Where similar objects are installed which penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.
5. Construction documents shall contain a diagram showing the building's pressure boundary in plan(s) and section(s) and a calculation of the area of the pressure boundary to be considered in the test.

**SDCI 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 semi-heated spaces, so these spaces are included when detailing the continuous air barrier and when determining the pressure boundary for conducting the air leakage test. However, unheated spaces are not included when determining the pressure boundary.

**C402.5.1.2 Air barrier compliance.** A continuous air barrier for the opaque building envelope shall comply with the following:

1. Group R dwelling units that are accessed directly from the outdoors shall meet the provisions of Section C402.5.2.
2. All other buildings or portions of buildings shall meet the provisions of Section C402.5.3.

**C402.5.2 Enclosure testing for dwelling and sleeping units accessed directly from the outdoors.** For dwelling units accessed directly from outdoors, the *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.25 cfm/ft$^2$ (1.27 L/s m$^2$) of the *testing unit enclosure area* at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope* and are accessed directly from the outdoors, each unit shall be considered an individual test-

ing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest *testing unit enclosure area*. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.
3. Test shall be accomplished using either a) both pressurization and depressurization or b) pressurization alone, but not depressurization alone. The test results shall be plotted against the correct P for pressurization in accordance with Section 9.4 of ASTM E779.

Where the measured air leakage rate exceeds 0.25 cfm/ft$^2$ (2.0 L/s × m$^2$) corrective action shall be taken to seal leaks in the air barrier in all units exceeding the target value and all untested units. Post-corrective action testing and repeated corrective action measures will be taken until the required air leakage rating is achieved. Final passing air leakage test results shall be submitted to the *code official*.

**C402.5.3 Building thermal envelope testing.** The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.25 cfm/ft$^2$ (1.27 L/s × m$^2$) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.
4. Test shall be accomplished using either a) both pressurization and depressurization or b) pressurization alone, but not depressurization alone. The test results shall be plotted against the correct P for pressurization in accordance with Section 9.4 of ASTM E779.

Where the measured air leakage rate exceeds 0.25 cfm/ft$^2$ (2.0 L/s × m$^2$) corrective action shall be taken to seal leaks in the air barrier. Post-corrective action testing and repeated corrective action measures will be taken until the required air leakage rating is achieved. Final passing of the air leakage test results shall be submitted to the *code official*.

**C402.5.4 Building test for mixed-use buildings.** Where a building is three or fewer stories above grade plane and contains both commercial and residential uses, the air barrier of the R-2 and R-3 occupancy areas of the building is permitted to be separately tested according to Section R402.4.1.2. Alternatively, it is permissible to test the air barrier of the entire building according to Section C402.5.3, provided that the tested air leakage rate does not exceed the rate specified in Section C402.5.3.

**C402.5.4.1 Low-rise residential building areas conforming to commercial energy code requirements.** Where the *residential building* provisions of this code require Group R-2 occupancy areas of 1, 2, and 3-story buildings to comply with the *commercial building* provisions of the code, the entire building shall be tested to meet the standards for commercial uses.

**C402.5.5 Rooms containing fuel-burning appliances.** Where combustion air is supplied through openings in an exterior wall to a room or space containing a space conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope*.
2. The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the building thermal envelope. Such rooms shall comply with all of the following:
   2.1. The walls, floor and ceiling that separate the enclosed room or space from the conditioned spaces shall be insulated to be at least equivalent to the insulation requirement of below grade walls as specified in Table C402.1.3 or C402.1.4.
   2.2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces be sealed in accordance with Section C402.5.1.1.
   2.3. The doors into the enclosed room or space shall be fully gasketed.
   2.4. Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.

2.5. Where the air duct supplying combustion air to the enclosed room or space passes through conditioned space, the duct shall be insulated to an *R*-value of not less than R-16.

**EXCEPTION:** Fireplaces and stoves complying with Sections 901 through 905 of the *International Mechanical Code*, and Section 2111.13 of the *International Building Code*.

**C402.5.6 Doors and access openings to shafts, chutes, stairways, and elevator lobbies.** Doors and access openings from conditioned space to shafts, chutes, stairways and elevator lobbies shall be gasketed, weatherstripped or sealed.

**EXCEPTIONS:**

1. Door openings required to comply with Section 716 of the *International Building Code*.
2. Doors and door openings required to comply with UL 1784 by the *International Building Code*.

**C402.5.7 Air intakes, exhaust openings, stairways and shafts.** Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Section C403.7.8.

**C402.5.8 Loading dock weatherseals.** Cargo door openings and loading dock door openings shall be equipped with weatherseals that restrict infiltration and provide direct contact along the top and sides of vehicles that are parked in the doorway.

**C402.5.9 Vestibules.** All building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the building entrance shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors. For the purposes of this section, "building entrances" shall include exit-only doors in buildings where separate doors for entering and exiting are provided.

Interior and exterior doors shall have a minimum distance between them of not less than 7 feet. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. Either the interior or exterior envelope of unconditioned vestibules shall comply with the requirements for a conditioned space. The building lobby is not considered a vestibule.

**EXCEPTION:** Vestibules are not required for the following:

1. Doors not intended to be used as building entrances.
2. Unfinished ground-level space greater than 3,000 square feet (298 $m^2$) if a note is included on the permit documents at each exterior entrance to the space stating "Vestibule required at time of tenant build-out if entrance serves a space greater than 3,000 square feet in area."
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors between an enclosed space smaller than 3,000 square feet (298 $m^2$) in area and the exterior of the building or the building entrance lobby, where those doors do not comprise one of the primary building entrance paths to the remainder of the building. The space must be enclosed and separated without transfer air paths from the primary building entrance paths. If there are doors between the space and the primary entrance path, then the doors shall be equipped with self-closing devices so the space acts as a vestibule for the primary building entrance.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. In buildings less than 3 stories above grade or in spaces that do not directly connect with the building elevator lobby, doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C408.2.3.
8. Building entrances in buildings that are less than four stories above grade and less than 10,000 $ft^2$ in area.
9. Elevator doors in parking garages provided that the elevators have an enclosed lobby at each level of the garage.
10. Entrances to semi-heated spaces.
11. Doors that are used only to access outdoor seating areas that are separated from adjacent walking areas by a fence or other barrier.

**SDCI Informative Note:** *Building entrance* is defined as the means ordinarily used to gain access to the building. Doors other than *building entrances*, such as those leading to service areas, mechanical rooms, electrical equipment rooms, outdoor seating areas 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 in parking garages also serve to reduce the flow of vehicle exhaust into the building.

**C402.5.10 Recessed lighting.** Recessed luminaires installed in the *building thermal envelope* shall be all of the following:

1. IC rated.
2. *Labeled* as having an air leakage rate of not more 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.
3. Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

**C402.5.11 Operable openings interlocking.** Where any operable openings to the outdoors are larger than 48 square feet (4.47 $m^2$) in area, such openings shall be interlocked with the heating and cooling system as required by Section C403.4.1.6.

**EXCEPTIONS:**

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where *approved* by the *code official*.
3. The outer entrance doors where located in the exterior wall and are part of a vestibule system.
4. Alterations to existing buildings.

## SECTION C403
## MECHANICAL SYSTEMS

**C403.1 General.** Mechanical systems and equipment serving heating, cooling, ventilating, and other needs shall comply with this section.

**EXCEPTIONS:**

1. Energy using equipment used by a manufacturing, industrial or commercial process other than for conditioning spaces or maintaining comfort and amenities for the occupants are exempt from all Section C403 subsections except for Section C403.3.2, Tables C403.3.2 (1) through (16) inclusive, Sections C403.3.4.1, C403.3.4.2, C403.3.4.3, C403.7.7, C403.9.2.1, C403.10.3, C403.11.2, and C403.11.3, as applicable. Data center and *computer room* HVAC equipment is not covered by this exception.
2. *Data center systems* are exempt from Sections C403.4 and C403.5, but shall comply with ASHRAE 90.4 Sections 6 and 8 according to Section C403.1.3.

**C403.1.1 HVAC total system performance ratio (HVAC TSPR).** For systems serving ((~~office (including medical office), retail, library, and education occupancies and buildings, which are subject to the requirements of Section C403.3.5 without exceptions, and the dwelling units and residential common areas within Group R-2 multi-family buildings~~)) occupancy areas included in Table C403.1.1, the *HVAC total system performance ratio* (*HVAC TSPR*) of the *proposed design* HVAC system shall be greater than or equal to the *HVAC TSPR* of the *standard reference design* as calculated according to Appendix D, Calculation of HVAC Total System Performance Ratio.

**Table C403.1.1**
**Occupancy Classifications Requiring TSPR**

| Occupancy Classification | Inclusions | Excluded |
|---|---|---|
| A | Library | All other Group A uses |
| B | Office, medical office | All other Group B uses |
| E | All occupancies included | |
| M | All occupancies included | |
| R | Dwelling units and associated common areas in Group R-2 areas of buildings | Groups R-1 and R-3 occupancies.<br>Sleeping units and associated common areas in Group R-2 areas of buildings |
| F, H, I, S, U | | All occupancies |

**EXCEPTIONS TO SECTION C403.1.1:**

1. Buildings in which the sum of the *conditioned floor area* of ((~~office (including medical office), retail, education, library and multifamily spaces~~)) occupancies included in the Inclusions column of Table C403.1.1 is less than 5,000 square feet. Areas that are eligible for any of the exceptions below do not count towards the 5,000 square feet.
2. HVAC systems using district heating water, chilled water or steam.
3. HVAC systems connected to a *low-carbon district energy exchange system*.

4. HVAC systems not included in Table D601.10.1.
5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air and water cooled chillers on the same chilled water loop.
6. HVAC systems included in Table D601.10.1 with parameters in Table D601.10.2 not identified as applicable to that HVAC system type.
7. HVAC systems served by heating water plants that include air to water or water to water heat pumps.
8. Underfloor air distribution and displacement ventilation HVAC systems.
9. Space conditioning systems that do not include *mechanical cooling*.
10. Alterations to existing buildings that do not substantially replace the entire HVAC system and are not serving initial build-out construction.
11. HVAC systems meeting all the requirements of the *standard reference design* HVAC system in Table D602.11, Standard Reference Design HVAC Systems.
12. Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170 including, but not limited to, surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation.
13. HVAC systems serving the following areas and spaces:
    - 13.1. Laundry rooms.
    - 13.2. Elevator machine rooms.
    - 13.3. Mechanical and electrical rooms.
    - 13.4. Data centers and computer rooms.
    - 13.5. Laboratories with fume hoods.
    - 13.6. Locker rooms with more than two showers.
    - 13.7. Natatoriums and rooms with saunas.
    - 13.8. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h.
    - 13.9. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.
    - 13.10. Cafeterias and dining rooms.

**SDCI Informative Note:** For more information regarding TSPR, see SDCI Tip 425 (Seattle SDCI Tip 425—HVAC Total System Performance Ratio) and the free online calculation tools developed by PNNL for this use linked on Page 2 of the Tip.

**C403.1.2 Calculation of heating and cooling loads.** Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with the procedures described in ANSI/ASHRAE/ACCA Standard 183 or by an *approved* equivalent computational procedure, using the design parameters specified in Chapter 3. Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE *HVAC Systems and Equipment Handbook* by an *approved* equivalent computational procedure.

**C403.1.3 Data centers.** *Data center systems* shall comply with this code and with Sections 6 and 8 of ASHRAE Standard 90.4.

**SDCI Informative Note:** The ASHRAE Standard 90.4 reference in Chapter 6 has been updated to the 2022 edition.

**C403.1.4 Use of electric resistance and fossil fuel-fired HVAC heating equipment.** HVAC heating energy shall not be provided by electric resistance or fossil fuel combustion appliances. For the purposes of this section, electric resistance HVAC heating appliances include, but are not limited to, electric baseboard, electric resistance fan coil and VAV electric resistance terminal reheat units and electric resistance boilers. For the purposes of this section, fossil fuel combustion HVAC heating appliances include, but are not limited to, appliances burning natural gas, heating oil, propane, or other fossil fuels.

**EXCEPTIONS:**

1. Low heating capacity. Buildings or areas of buildings, other than *dwelling units* or sleeping units, that meet the interior temperature requirements of Chapter 12 of the *International Building Code* with a total installed HVAC heating capacity no greater than 8.5 Btu/h (2.5 watts) per square foot of *conditioned space* are permitted to be heated using electric resistance appliances.

2. Dwelling and sleeping units. Dwelling or sleeping units are permitted to be heated using electric resistance appliances as long as the installed HVAC heating capacity in any separate space is not greater than ((÷)) specified in 2.1 through 2.3. Where a single dwelling unit includes multiple habitable spaces that are all heated with electric resistance heat, individual spaces are permitted to have more electric resistance heating capacity than specified in 2.1 through 2.3, where the total electric resistance heating capacity for the dwelling unit is less than or equal to the total allowed.

**SDCI Informative Note for exception 2:** As an example, a one-bedroom apartment could, instead of placing 750 watts of heating in the living room and another 750 watts in the bedroom (1,500 watt total), place 1,000 watts in the living room and 500 watts in the bedroom, for the same 1,500 watt total.

2.1. Seven hundred fifty (750) watts in Climate Zone 4, ((~~and 1000 watts in Climate Zone 5~~)) in each habitable space with exterior fenestration.

2.2. One thousand (1000) watts in Climate Zone 4, ((~~and 1300 watts in Climate Zone 5~~)) for each habitable space that has two primary walls facing different cardinal directions, each with exterior fenestration. Bay windows and other minor offsets are not considered primary walls.

2.3. Two hundred fifty (250) watts in spaces adjoining the *building thermal envelope* but without exterior fenestration.

For the purposes of this section, habitable space is as defined in the International Building Code. ((~~For buildings in locations with exterior design conditions below 4°F (-16°C), an additional 250 watts above that allowed for Climate Zone 5 is permitted in each space with fenestration.~~))

3. Small buildings. Buildings with less than 2,500 square feet (232 $m^2$) of *conditioned floor area* are permitted to be heated using electric resistance appliances.

4. Defrost. Heat pumps are permitted to utilize electric resistance heating when a heat pump defrost cycle is required and is in operation.

5. Air-to-air heat pumps. Buildings are permitted to utilize electric resistance supplemental heating for air-to-air heat pumps that meet all of the following conditions:

5.1. Internal electric resistance heaters have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery.

5.2. The heat pump controls are configured to use the compressor as the first stage of heating down to an outdoor air temperature of 17°F (-8°C) or lower except when in defrost.

**EXCEPTIONS TO 5.2:**

1. Packaged terminal heat pumps (PTHPs) that comply with the minimum heating efficiency requirements in Table C403.3.2(4) are exempt from heating pump controls capable of operating the compressor as the first stage of heating down to an outdoor air temperature of 17°F (-8°C) or lower.
2. Heat pumps whose minimum efficiency is regulated by NAECA and whose ratings meet the requirements shown in Table C403.3.2(2) and include all usage of internal electric resistance heating are exempt from heat pump controls capable of operating the compressor as the first state of heating down to an outdoor air temperature of 17°F (-8°C) or lower.

5.3. The heat pump complies with one of the following:

5.3.1. Controlled by a digital or electronic thermostat designed for heat pump use that energizes the supplemental heat only when the heat pump has insufficient capacity to maintain set point or to warm up the space at a sufficient rate.

5.3.2. Controlled by a multistage space thermostat and an outdoor air thermostat wired to energize supplemental heat only on the last stage of the space thermostat and when outdoor air temperature is less than 32°F (0°C) except when in defrost.

5.3.3. The minimum efficiency of the heat pump is regulated by NAECA, its rating meets the requirements shown in Table C403.3.2(2), and its rating includes all usage of internal electric resistance heating.

5.4. The heat pump rated heating capacity is sized to meet the heating load at an outdoor air temperature of 32°F (0°C) or lower and has a rated heating capacity at 47°F (8°C) no less than 2 times greater than supplemental heating capacity in Climate Zone 4 and no less than the supplemental heating capacity in Climate Zone 5, or utilizes the smallest available factory-available internal electric resistance heater.

6. Air-to-water heat pumps. Buildings are permitted to utilize electric resistance (((~~for Climate Zone 4 or 5) or fossil fuel-fired (for Climate Zone 5)~~))) auxiliary heating to supplement heat pump heating for hydronic heating systems that meet all of the following conditions:
   6.1. Controls for the auxiliary heating sources are configured to lock out the supplemental heat when the outside air temperature is above 36°F (2°C), unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
   6.2. The heat pump controls are configured to use the compressor as the first stage of heating down to the lowest exterior design temperature for which the equipment is rated except during startup or defrost operation.
   6.3. The heat pump rated heating capacity at 47°F (8°C) is no less than 75 percent of the design heating load at 29°F (-2°C).
7. Ground source heat pumps. Buildings are permitted to utilize electric resistance supplemental heating for hydronic heating systems with ground source heat pump equipment that meets all of the following conditions:
   7.1. Controls for the auxiliary heating sources are configured to lock out the supplemental heat when the equipment source-side entering water temperature is above 42°F (6°C), unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
   7.2. The heat pump controls are configured to use the compressor as the first stage of heating.
   7.3. The ground source heat exchanger shall be sized so that the heat pump annual heating output is no less than 70 percent of the total annual heating output in the final year of a 30-year simulation using IGSHPA listed simulation software.
8. Small systems. Buildings in which electric resistance or fossil fuel appliances, including decorative appliances, either provide less than 5 percent of the total building HVAC system heating capacity or serve less than 5 percent of the *conditioned floor area*.
9. Specific conditions. Portions of buildings that require fossil fuel or electric resistance space heating for specific conditions *approved* by the *code official* for research, health care, process or other specific needs that cannot practicably be served by heat pump or other space heating systems. This does not constitute a blanket exception for any occupancy type.
10. Kitchen make-up air. Make-up air for commercial kitchen exhaust systems required to be tempered by Section 508.1.1 of the *International Mechanical Code* is permitted to be heated by using fossil fuel in Climate Zone 5 or electric resistance in Climate Zone 4 or 5.
11. District energy. Steam or hot water district energy systems that utilize fossil fuels as their primary source of heat energy, that serve multiple buildings, and that were already in existence prior to the effective date of this code, including more energy-efficient upgrades to such existing systems, are permitted to serve as the primary heating energy source.
12. Heat tape. Heat tape is permitted where it protects water-filled equipment and piping located outside of the *building thermal envelope*, provided that it is configured and controlled to be automatically turned off when the outside air temperature is above 40°F (4°C).
13. Temporary systems. Temporary electric resistance heating systems are permitted where serving future tenant spaces that are unfinished and unoccupied, provided that the heating equipment is sized and controlled to achieve interior space temperatures no higher than 40°F (4°C).
14. Pasteurization. Electric resistance heat controls are permitted to reset the supply water temperature of hydronic heating systems that serve service water heating heat exchangers during pasteurization cycles of the service hot water storage volume. The hydronic heating system supply water temperature shall be configured to be 145°F (63°C) or lower during the pasteurization cycle.
15. Freeze protection. Heating systems sized for spaces with indoor design conditions of 45°F (7°C) and intended for freeze protection are permitted to use electric resistance. The building envelope of any such space shall be insulated in compliance with Section C402.1.
16. DOAS ERV auxiliary heat. Dedicated outdoor air systems with energy recovery ventilation are permitted to utilize ((~~fossil fuel for Climate Zone 5 or~~)) electric resistance ((~~in Climate Zone 4 or 5~~)) for auxiliary heating to preheat outdoor air for defrost or as auxiliary supplemental heat to temper supply air to 55°F (13°C) or lower for buildings or portions of buildings that do not have hydronic heating systems.
17. Low-carbon district energy systems. Low-carbon district energy systems that meet the definitions of *low-carbon district energy exchange system* or *low-carbon district heating and cooling or heating only systems*.
18. Essential facilities. Groups I-2 and I-3 occupancies that by regulation are required to have in place redundant emergency backup systems, and research laboratories, are permitted to use fossil fuels for emergency generators

and for redundant emergency space heating and water heating appliances, provided that such systems are sized and controlled to operate only upon loss of electrical power.

19. Standby HVAC heating equipment. Standby HVAC heating equipment provided in addition to the primary heating system, and controlled such that it will only be used when the primary heating equipment is not available, is permitted to be electric resistance.
20. Emergency generators. Generators serving emergency power, legally required standby power, or optional standby power are permitted to use fossil fuels.
21. Wastewater heat recovery heat pumps. Buildings are permitted to utilize electric resistance auxiliary heating to supplement heat pump heating for hydronic heating systems with wastewater heat recovery or other approved waste heat recovery systems provided the heat pump equipment that meets all of the following conditions:
    - 21.1. Controls for the auxiliary resistance heating are configured to lock out the supplemental heat when the equipment source-side entering water temperature is above 42°F, unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
    - 21.2. The heat pump controls are configured to use the compressor as the first stage of heating.
    - 21.3. The wastewater heat exchanger and heat pumps or other heat pump supplemental systems shall be sized so that the heat pump rated heating capacity at heat pump design entering water temperature conditions or other heat pump heating systems are no less than 75 percent of the design heating load at 29°F. Wastewater heat exchanger source side shall be sized for a design wastewater entering temperature of 55°F or lower.
22. Mechanical systems located outside of the building thermal envelope. Mechanical systems providing heat outside of the thermal envelope that comply with Section C403.11 are permitted to utilize electric resistance appliances. Snow- and ice-melt systems that comply with Section C403.11.2 are permitted to utilize electric resistance heat to back up the primary electric heat pump heating system in accordance with Exceptions 6 and 7 of Section C403.1.4.

**C403.2 System design.** Mechanical systems shall be designed to comply with Sections C403.2.1 and C403.2.4. Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.13, such elements shall comply with the applicable provisions of those sections.

**C403.2.1 Zone isolation required.** HVAC systems, DOAS and exhaust systems serving areas that are intended to operate or be occupied nonsimultaneously shall be divided into separate isolation areas. Zones intended to be occupied simultaneously may be grouped into a single isolation area provided the combined total area does not exceed 25,000 square feet (2323 $m^2$) of conditioned floor area and does not include more than one floor. Each isolation area shall be equipped with isolation devices and controls configured to automatically shut off the supply of conditioned air and outdoor air to and exhaust air from the isolation area. Each isolation area shall be controlled independently by a device meeting the requirements of Section C403.4.2.2. Central systems and plants shall be provided with controls and devices that will allow system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.

**EXCEPTIONS:**

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

**C403.2.2 Ventilation and exhaust.**

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

**EXCEPTIONS:**

1. The mechanical system may supply outdoor air at rates higher than the limit above when it is used for particulate or VOC dilution, economizing or night flushing, dehumidification, pressurization, exhaust make-up, or other process air delivery. Outdoor air shall be reduced to the minimum ventilation rates when not required for the preceding uses.
2. Air systems supplying dwelling or sleeping units within Group R-1, R-2 or I-2 occupancies.
3. Alterations that replace less than half of the total heating and cooling capacity of the system.

**EXCEPTIONS:**

1. Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.
2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that are configured to sequence the operation of each unit based on load.

**C403.3.2 HVAC equipment performance requirements.** Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2 (16) when tested and rated in accordance with the applicable test procedure. After new equipment efficiency values including HSPF2, EER2, and SEER2 have been published by the US Department of Energy, equipment is permitted to meet those values in lieu of the table values. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of AHRI 400. 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.

Air-to-water heat pump manufacturers shall report the hourly heating output or heating efficiency with and without defrost operation at 32°F, in addition to meeting the efficiency requirements of Table C403.3.2(15) at the AHRI 550/590 applicable leaving water temperatures. The hourly heating output or heating efficiency with and without defrost operation shall be documented on the mechanical permit application documents.

**EXCEPTION:** Heat recovery chillers and air-to-water heat pumps covered under Table C403.3.2(15), are not required to be listed in the AHRI certification program for AHRI 550/590. The equipment heating and cooling efficiency ratings shall be supported by data furnished by the manufacturer at AHRI 550/590 conditions. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements.

**SDCI Informative Note:** Table C403.3.2.(13) is from ASHRAE 90.1-2019. At the time of the adoption of the 2021 SEC it was not clear whether any air-to-water heat pumps or heat recovery chillers would be listed in the AHRI Certified Product Directory. https://www.ahridirectory.org/ According to AHRI 550/590 Section 5.3, "Full and part-load application ratings shall include the range of Rating Conditions listed in Table 2 or be within the operating limits of the equipment."

**C403.3.2.1 Gas-fired and oil-fired forced air furnaces.** 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.

**SDCI Informative Note:** Fossil fuel-fired heating equipment is generally prohibited by Section C403.1.4.

**C403.3.2.2 Hydronic and multiple-zone HVAC system controls and equipment.** Hydronic and multiple-zone HVAC system controls and equipment shall comply with this section.

For buildings with a total equipment cooling capacity of 300 tons and above, the equipment shall comply with one of the following:

1. No one unit shall have a cooling capacity of more than 2/3 of the total installed cooling equipment capacity;
2. The equipment shall have a variable speed drive; or
3. The equipment shall have multiple compressors.

**C403.3.2.3 Chillers.** Chilled water plants and buildings with more than 500 tons total cooling capacity shall not have more than 100 tons provided by air-cooled chillers.

**EXCEPTIONS:**

1. Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.
2. Air-cooled chillers with minimum efficiencies at least 10 percent higher than those listed in Table C403.3.2(3).
3. Replacement of existing air-cooled chiller equipment.
4. Air-to-water heat pump units that are configured to provide both heating and cooling and that are rated in accordance with AHRI 550/590.

**Table C403.3.4.3**
**Boiler Stack-Gas Oxygen Concentrations**

| Boiler System Type | Maximum Stack-Gas Oxygen Concentration[a] |
|---|---|
| Less than 10% of the boiler system capacity is used for process applications at design conditions | 5% |
| All others | 3% |

a Concentration levels measured by volume on a dry basis over firing rates of 20 to 100 percent.

**C403.3.4.4 Boiler turndown.** *Boiler systems* with design input of greater than 1,000,000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table C403.3.4.4.

The system turndown requirement shall be met through the use of multiple single input boilers, one or more *modulating boilers* or a combination of single input and modulating boilers.

**Table C403.3.4.4**
**Boiler Turndown**

| Boiler System Design Input (Btu/h) | Minimum Turndown Ratio |
|---|---|
| ≥ 1,000,000 and less than or equal to 5,000,000 | 3 to 1 |
| ≥ 5,000,000 and less than or equal to 10,000,000 | 4 to 1 |
| ≥ 10,000,000 | 5 to 1 |

**C403.3.4.5 Buildings with high-capacity space-heating gas boiler systems.** New buildings with gas hot water boiler systems for space heating with a total system input of at least 1,000,000 Btu/h but not more than 10,000,000 Btu/h shall comply with this section.

**EXCEPTIONS:**

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

**C403.3.4.5.1 Boiler efficiency.** Gas hot water boilers shall have a minimum thermal efficiency (Et) of 90 percent when rated in accordance with the test procedures in Table C403.3.2(6). Systems with multiple boilers are allowed to meet this requirement if the space-heating input provided by equipment with thermal efficiency (Et) above and below 90 percent provides an input capacity-weighted average thermal efficiency of at least 90 percent. For boilers rated only for combustion efficiency, the calculation for the input capacity-weighted average thermal efficiency shall use the combustion efficiency value.

**C403.3.4.5.2 Hot water distribution system design.** The hot water distribution system shall be designed to meet all of the following:

1. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F (48.9°C) or less.
2. Under all operating conditions, the water temperature entering the boiler is 120°F (48.9°C) or less, or the flow rate of supply hot water that recirculates directly into the return system, such as three-way valves or minimum flow bypass controls, shall be no greater than 20 percent of the design flow of the operating boilers.

**C403.3.5 Dedicated outdoor air systems (DOAS).** For buildings with occupancies as shown in Table C403.3.5, outdoor air shall be provided to each occupied space by a dedicated outdoor air system (DOAS) which delivers 100 percent outdoor air without requiring operation of the heating and cooling system fans for ventilation air delivery.

**EXCEPTIONS:**

1. Occupied spaces that are not ventilated by a mechanical ventilation system and are only ventilated by a natural ventilation system in accordance with Section 402 of the *International Mechanical Code*.
2. High efficiency variable air volume (VAV) systems complying with Section C403.6.10 for occupancy classifications other than Groups A-1, A-2 and A-3 as specified in Table C403.3.5, and high efficiency VAV systems complying with Section C403.12 for occupancy classification Groups A-1, A-2 and A-3 as specified in Table C403.3.5. This exception shall not be used as a substitution for a DOAS per Section C406.6.

3. Spaces that are within building types not subject to the requirements of Section C403.3.5, and that qualify as accessory occupancies according to Section 508.2 of the International Building Code, are not required to comply with this section.

**Table C403.3.5**
**Occupancy Classifications Requiring DOAS**

| Occupancy Classification[a] | Inclusions | Exempted |
|---|---|---|
| A-1 | All occupancies not specifically exempted | Television and radio studios |
| A-2 | Casinos (gaming area) | All other A-2 occupancies |
| A-3 | Lecture halls, community halls, exhibition halls, gymnasiums, courtrooms, libraries, places of religious worship | All other A-3 occupancies |
| A-4, A-5 | | All occupancies excluded |
| B | All occupancies not specifically exempted | Food processing establishments including commercial kitchens, restaurants, cafeterias; laboratories for testing and research; data processing facilities and telephone exchanges; air traffic control towers; animal hospitals, kennels, pounds; ambulatory care facilities |
| F, H, I, R, S, U | | All occupancies excluded |
| E, M | All occupancies included | |

a. Occupancy classification from the *International Building Code* Chapter 3.

**C403.3.5.1 DOAS with energy recovery ventilation.** The DOAS shall include energy recovery. The *energy recovery ventilation* system shall have a ((~~68~~)) 67 percent minimum sensible recovery effectiveness of the energy recovery device as calculated in accordance with Equation 4-9 or provide an enthalpy recovery ratio of not less than 60 percent at design conditions in accordance with Section C403.7.6. The airflow rate thresholds in Section C403.7.6 that define when the energy recovery requirements in that section do not apply, are not applicable to this section. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C) at 30 percent relative humidity, or as calculated by the registered design professional.

$$\text{Sensible Recovery Effectiveness} = \frac{T_{OA} - T_{SA}}{T_{OA} - T_{RA}} \qquad \textbf{(Equation 4-9)}$$

Where:

$T_{OA}$ = Design outdoor air dry bulb temperature entering the energy recovery device.

$T_{SA}$ = Supply air dry bulb temperature leaving the energy recovery device at design temperatures and airflow conditions, as selected for the proposed DOAS unit(s).

$T_{RA}$ = Design return air dry bulb temperature.

**EXCEPTIONS:**

1. Systems installed for the sole purpose of providing makeup air for systems exhausting toxic, flammable, paint, or corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.
2. Heat recovery and energy recovery ventilators (H/ERV) that are rated and *listed* in accordance with HVI 920 can demonstrate compliance with the sensible recovery effectiveness requirement using the adjusted sensible recovery effectiveness (ASRE) rating of the equipment at 32°F test conditions. Applied flow rate for ASRE rating shall be no less than the design flow rate or the closest value interpolated between two listed flow rates.

((~~3. The energy recovery systems for Group R-2 occupancies are permitted to provide 50 percent minimum sensible heat recovery effectiveness in lieu of 68 percent sensible recovery effectiveness in accordance with Section C403.7.6. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C) or as determined by an *approved* calculation procedure.~~))

**C403.3.5.2 DOAS fan power.** For a DOAS that does not have at least one fan or fan array with fan electrical input power ≥ 1 kW, the total combined fan power shall not exceed ((~~1 watt~~)) 0.8 watts per cfm of outdoor air as calculated in accordance with Equation 4-10 using design maximum airflows and external static pressures. For a DOAS with at least one fan or fan array with fan electrical input power ≤ 1 kW, the DOAS shall comply with the fan power limitations of Section C403.8.1. DOAS total combined fan power shall include all supply, exhaust and other fans utilized for the

purpose of ventilation. This fan power restriction applies to each DOAS in the permitted project, but does not include the fan power associated with the zonal heating and cooling equipment.

$$\text{DOAS Total Combined Fan Power } \left(\frac{Watts}{CFM}\right) = \sum\left(\frac{Fan\ bhp}{\eta_m}\right) \times \frac{746}{CFM_{supply}} \quad \textbf{(Equation 4-10)}$$

Where:

Fan bhp = Brake horsepower for each supply, exhaust and other fan in the system at design maximum airflow rate.

$\eta_m$ = Fan motor efficiency including all motor, drive and other losses for each fan in the system.

$CFM_{supply}$ = Design maximum airflow rate of outdoor (supply) air.

**C403.3.5.3 Heating and cooling system fan controls.** Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the *zone*.

**EXCEPTION:** Fans used for heating and cooling using less than 0.12 watts per cfm may operate when space temperatures are within the setpoint deadband (Section C403.4.1.2) to provide destratification and air mixing in the space.

**C403.3.5.4 Decoupled DOAS supply air.** The DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating and/or cooling coils.

**EXCEPTIONS:**

1. Active chilled beam systems.
2. Sensible only cooling terminal units with pressure independent variable airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.
3. Terminal heating and/or cooling units that comply with the low fan power allowance requirements in the exception of Section C403.3.5.3.

**C403.3.5.5 Supplemental heating and cooling.** Supply air stream heating in the DOAS system shall comply with Section C403.7.3. Cooling is permitted for dehumidification only. Cooling coil shall be sized to meet peak dehumidification requirement at design outdoor temperatures, and no larger. Cooling coil shall be controlled to maintain supply air relative humidity or *zone* relative humidity.

**EXCEPTIONS:**

1. Heating permitted for defrost control shall be locked out when outside air temperatures are above 35°F (2°C). Supplemental heating for defrost shall modulate to 10 percent of the peak capacity, and shall be sized to prevent ((~~frost/damage dame~~)) frost damage to the unit at design temperatures and provide supply air less than or equal to 55°F (13°C).
2. A DOAS serving Group R-1 or R-2 occupancy spaces that are served by zonal heating systems, but not by zonal heat pumps, air conditioners, or other zonal mechanical cooling systems, is permitted to be provided with a supplemental heating and cooling system in compliance with Section C403.1.4.

**C403.3.5.6 Impracticality.** Where the *code official* determines that full compliance with one or more of the requirements in Sections C403.3.5.1 through C403.3.5.5 is impractical, it is permissible to provide an approved alternate means of compliance that achieves a comparable level of energy efficiency as the requirement(s) deemed impractical. For the purposes of this section, impractical means that an HVAC system complying with all requirements in Section C403.3.5 cannot effectively be utilized due to an unusual use or configuration of the building.

**C403.3.6 (Reserved) ((~~Ventilation for Group R-2 occupancy.~~** ~~For all Group R-2 dwelling and sleeping units, a balanced ventilation system with a heat recovery system shall provide outdoor air directly to all habitable spaces. The heat recovery system shall have a 60 percent minimum sensible recovery effectiveness as calculated in accordance with Section C403.3.5.1. The ventilation system shall allow for the design flow rates to be tested and verified at each habitable space as part of the commissioning process in accordance with Section C408.2.2.~~

~~**EXCEPTION:** Heat recovery and energy recovery ventilators (H/ERV) that are rated and listed in accordance with HVI 920 can demonstrate compliance with the sensible recovery effectiveness requirement using the adjusted sensible recovery effectiveness (ASRE) rating of the equipment at 32°F test conditions. Applied flow rate for ASRE rating shall be no less than the design flow rate or the closest value interpolated between two listed flow rates.~~))

**SDCI Informative Note:** See Section C403.7.6.1 for Ventilation for Group R-2 occupancies.

**C403.3.7 Hydronic system flow rate.** 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 C403.3.7 for the appropriate total annual hours of operation. Pipe sizes 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 permitted to be selected from the "Variable Flow/Variable Speed" columns. All others shall be selected from the "Other" columns.

**EXCEPTION:** Design flow rates exceeding the values in Table C403.3.7 are permitted 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.

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

**Table C403.3.7**
**Piping System Design Maximum Flow Rate in GPM[a]**

| Pipe Size | ≤ 2000 hours/year | | > 2000 and ≤ 4400 hours/year | | > 4400 hours/year | |
|---|---|---|---|---|---|---|
| (in) | Other | Variable Flow/ Variable Speed | Other | Variable Flow/ Variable Speed | Other | Variable Flow/ Variable Speed |
| 2-1/2 | 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 |
| Maximum velocity for pipes over 14 to 24 in. in size | 8.5 ft/s | 13.0 ft/s | 6.5 ft/s | 9.5 ft/s | 5.0 ft/s | 7.5 ft/s |

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

**C403.3.8 Hydronic coil selection.** Hydronic coils shall comply with Sections C403.3.8.1 and C403.3.8.2.

**EXCEPTION:** Replacement coils within existing equipment.

**C403.3.8.1 Chilled-water coil selection.** Chilled-water cooling coils shall be selected to provide a 15°F or higher temperature difference between leaving and entering water temperatures and a minimum of 57°F leaving water temperature at design conditions.

**EXCEPTIONS:**

1. Chilled-water cooling coils that have an airside pressure drop exceeding 0.70 in. of water when rated at 500 fpm face velocity and dry conditions (no condensation).
2. Individual fan-cooling units with a design supply airflow rate ≤ 5000 cfm.
3. Constant-air-volume systems.
4. Coils selected at the maximum temperature difference allowed by the cooling plant equipment manufacturer's approved operating conditions.
5. Passive coils (no mechanically supplied airflow).
6. Coils with design entering chilled-water temperature ≥ 50°F (10°C).
7. Coils with design entering air dry-bulb temperature ≤ 65°F (18°C).

**C403.3.8.2 Hot-water coil selection.** Hot-water heating coils shall be selected to provide a maximum 20°F temperature difference between leaving and entering water temperatures and a maximum of 118°F (48°C) entering water temperature at design conditions.

**EXCEPTIONS:**

1. Hot-water heating systems which utilize heat pumps as the primary source.
2. Individual terminal fan units with a design supply airflow rate ≤ 1500 cfm are exempt from the 20°F maximum temperature difference between leaving and entering water temperature requirement.
3. Passive coils (no mechanically supplied airflow).
4. Coils with design leaving air temperature ≥ 95°F (35°C).

**C403.4 HVAC system controls.** HVAC systems shall be provided with controls in accordance with Sections C403.4.1 through C403.4.12 and shall be capable of and configured to implement all required control functions in this code.

**C403.4.1 Thermostatic controls.** The supply of heating and cooling energy to each *zone* shall be controlled by individual thermostatic controls capable of responding to temperature within the *zone*. Controls in the same zone or in neighboring zones connected by openings larger than 10 percent of the floor area of either zone shall not allow for simultaneous heating and cooling. At a minimum, each floor of a building shall be considered as a separate zone. Controls on systems required to have economizers and serving single zones shall have multiple cooling stage capability and activate the economizer when appropriate as the first stage of cooling. See Section C403.5 for further economizer requirements. Where humidification or dehumidification or both is provided, at least one humidity control device shall be provided for each humidity control system.

**EXCEPTIONS:**

1. Independent perimeter systems that are designed to offset only building envelope heat losses or gains or both serving one or more perimeter *zones* also served by an interior system provided:
   1.1. The perimeter system includes at least one thermostatic control *zone* for each building exposure having exterior walls facing only one orientation (within +/-45 degrees) (0.8 rad) for more than 50 contiguous feet (15,240 mm);
   1.2. The perimeter system heating and cooling supply is controlled by a thermostat located within the *zones* served by the system; and
   1.3. Controls are configured to prevent the perimeter system from operating in a different heating or cooling mode from the other equipment within the zones or from neighboring zones connected by openings larger than 10 percent of the floor area of either zone.
2. Where an interior zone and a perimeter zone are open to each other with permanent openings larger than 10 percent of the floor area of either zone, cooling in the interior zone is permitted to operate at times when the perimeter zone is in heating and the interior zone temperature is at least 5°F (2.8°C) higher than the perimeter zone temperature. For the purposes of this exception, a permanent opening is an opening without doors or other operable closures.
3. Dedicated outdoor air units that provide ventilation air, make-up air or replacement air for exhaust systems are permitted to be controlled based on supply air temperature. The supply air temperature shall be controlled to a maximum of 65°F (18.3°C) in heating and a minimum of 72°F (22°C) in cooling unless the supply air temperature is being reset based on the status of cooling or heating in the zones served or it being reset based on outdoor air temperature.

((~~**C403.4.1.1 Heat pump supplementary heat control.** Unitary air cooled heat pumps shall include microprocessor controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall be installed with controls that prevent supplemental heater operation above 40°F (4.4°C). Heat pumps equipped with internal electric resistance heaters shall have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles. Heat pumps equipped with supplemental heaters shall comply with all conditions of Section C403.1.4.~~

~~**EXCEPTIONS:**~~

~~1. Packaged terminal heat pumps (PTHPs) of less than 2 tons (24,000 Btu/hr) cooling capacity that have reverse-cycle demand defrost and are configured to operate in heat pump mode whenever the outdoor air temperatures are above 25°F (-3.9°C) and the unit is not in defrost.~~

~~2. Heat pumps whose minimum efficiency is regulated by NAECA and whose ratings meet the requirements shown in Table C403.3.2(2) and include all usage of internal electric resistance heating.~~))

**C403.4.1.1 Heat pump supplementary heat control.** Heat pumps equipped with internal electric resistance heaters shall have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles. Heat pumps equipped with supplementary heaters shall comply with all conditions of Section C403.1.4,

**EXCEPTIONS:**

1. Packaged terminal heat pumps (PTHPs) of less than 2 tons (24,000 Btu/hr) cooling capacity that have reverse-cycle demand defrost and are configured to operate in heat pump mode whenever the outdoor air temperatures are above 25°F (-3.9°C) and the unit is not in defrost.

2. Heat pumps whose minimum efficiency is regulated by NAECA and whose ratings meet the requirements shown in Table C403.3.2(2) and include all usage of internal electric resistance heating.

**C403.4.1.2 Deadband.** Where used to control both heating and cooling, zone thermostatic controls shall be configured to provide a temperature range or deadband of at least 5°F (2.8°C) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

**EXCEPTIONS:**

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

**C403.4.1.3 Setpoint overlap restriction.** Where a *zone* has a separate heating and a separate cooling thermostatic control located within the zone, a limit switch, mechanical stop or direct digital control system with software programming shall be configured to prevent the heating setpoint from exceeding the cooling setpoint and to maintain a deadband in accordance with Section C403.4.1.2.

**C403.4.1.4 Heated or cooled vestibules and air curtains.** The heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F (7°C). Vestibule heating and cooling systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F (16°C) and cooling to a temperature not less than 85°F (29°C).

**EXCEPTIONS:**

1. Control of heating or cooling provided by transfer air that would otherwise be exhausted.
2. Vestibule heating only systems are permitted to be controlled without an outdoor air temperature lockout when controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 45°F (7°C) where required for freeze protection of piping and sprinkler heads located in the vestibule.

**C403.4.1.5 Hot water boiler outdoor temperature setback control.** Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

**C403.4.1.6 Operable opening switches for HVAC system thermostatic control.** Operable openings meeting the minimum size criteria of Section C402.5.11 and that open to the outdoors from a conditioned space must have controls configured to do the following once doors have been open for 5 minutes:

1. Disable the mechanical heating to the zone or reset the space heating temperature setpoint to 55°F or less within 5 minutes of the door open enable signal.
2. Disable the mechanical cooling to the zone or reset the space cooling temperature setpoint to 85°F or more within 5 minutes of the door open enable signal.

**EXCEPTION:** Hydronic radiant heating and cooling systems.

**C403.4.1.7 Demand responsive controls.** Thermostatic controls for heating or cooling systems shall be provided with *demand responsive controls* capable of increasing the cooling setpoint and decreasing the heating setpoint by no less than 4°F (2.2°C). The thermostatic controls shall be capable of performing all other functions provided by the control when the *demand responsive controls* are not available. Systems with *direct digital control* of individual *zones* report to a central control panel shall be capable of remotely increasing the cooling setpoint and decreasing the heating setpoint for each *zone* by no less than 4°F (2.2°C).

**EXCEPTIONS:**

1. Health care and assisted living facilities.
2. Group R-2 occupancy dwelling and sleeping units.

**C403.4.2 Off-hour controls.** For all occupancies other than Group R, and for *conditioned spaces* other than *dwelling units* and *sleeping units* within Group R occupancies, each *zone* shall be provided with thermostatic setback controls that are controlled by either an automatic time clock or programmable control system.

**EXCEPTIONS:**

1. *Zones* that will be operated continuously.
2. *Zones* with a full HVAC load demand not exceeding 6,800 Btu/h (2 kW) and having a manual shutoff switch located with *ready access*.

solution, i.e. 32°F (0°C) for 100 percent water applications, and 18°F (-7.8°C) for 20 percent by mass propylene glycol solution.

2. Where an open-circuit cooling tower is used directly in the heat pump loop, an *automatic* valve shall be installed to bypass all heat pump water flow around the open-circuit cooling tower.
3. Where an open-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the open-circuit cooling tower from the heat pump loop, heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

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

**C403.4.3.3.3 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 C403.4.6.

**C403.4.4 Part load controls.** Hydronic systems greater than or equal to 300,000 Btu/h (88 kW) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to:

1. Automatically reset the supply-water temperatures in response to varying building heating and cooling demand using coil valve position, zone-return water temperature or outdoor air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.

   **EXCEPTIONS:**

   1. Hydronic systems serving hydronic heat pumps.
   2. Hydronic systems with thermal energy storage where resetting the supply-water temperature would reduce the capacity of the storage.
2. Automatically vary fluid flow for hydronic systems with a combined pump motor capacity of 2 hp or larger with three or more control valves or other devices by reducing the system design flow rate by not less than 50 percent or the maximum reduction allowed by the equipment manufacturer for proper operation of equipment by valves that modulate or step open and close, or pumps that modulate or turn on and off as a function of load.
3. Automatically vary pump flow on heating water systems, chilled-water systems and heat rejection loops serving water-cooled unitary air conditioners as follows:

   3.1. Where pumps operate continuously or operate based on a time schedule, pumps with nominal output motor power of 2 hp or more shall have a variable speed drive.

   3.2. Where pumps have automatic direct digital control configured to operate pumps only when zone heating or cooling is required, a variable speed drive shall be provided for pumps with motors having the same or greater nominal output power indicated in Table C403.4.4 based on the climate zone and system served.
4. Where variable speed drive is required by Item 3 of this section, pump motor power input shall be not more than 30 percent of design wattage at 50 percent of the design water flow. Pump flow shall be controlled to maintain one control valve nearly wide open or to satisfy the minimum differential pressure.

   **EXCEPTIONS:**

   1. Supply-water temperature reset is not required for chilled-water systems supplied by off-site district chilled water or chilled water from ice storage systems.
   2. Variable pump flow is not required on dedicated coil circulation pumps where needed for freeze protection.
   3. Variable pump flow is not required on dedicated equipment circulation pumps where configured in primary/secondary design to provide the minimum flow requirements of the equipment manufacturer for proper operation of equipment.
   4. Variable speed drives are not required on heating water pumps where more than 50 percent of annual heat is generated by an electric boiler.

**Table C403.4.4**
**Variable Speed Drive (VSD) Requirements for Demand-Controlled Pumps**

| Climate Zones 4c, 5b | VSD Required for Motors with Rated Output of at Least |
|---|---|
| Heating water pumps | ≥ ((~~7.5~~)) 5.0 hp |
| Chilled water and heat rejection loop pumps | ≥ ((~~7.5~~)) 5.0 hp |

**C403.4.5 Pump isolation.** Chilled water plants including more than one chiller shall be capable of and configured to reduce flow automatically through the chiller plant when a chiller is shut down and automatically shut off flow to chillers that are shut down. Chillers piped in series for the purpose of increased temperature differential shall be considered as one chiller.

*Boiler systems* including more than one boiler shall be capable of and configured to reduce flow automatically through the *boiler system* when a boiler is shut down.

**C403.4.6 Variable flow controls.** Individual pumps required by this code to have variable speed control shall be controlled in one of the following manners:

1. For systems having a combined pump motor horsepower less than or equal to 20 hp (15 kW) and without direct digital control of individual coils, pump speed shall be a function of either:
    1.1. Required differential pressure; or
    1.2. Reset directly based on zone hydronic demand, or other zone load indicators; or
    1.3. Reset directly based on pump power and pump differential pressure; or
    1.4. Reset directly by an integral controller based on the relationship between variable speed controller frequency and power.
2. For systems having a combined pump motor horsepower that exceeds 20 hp (15 kW) or smaller systems with direct digital control, pump speed shall be a function of either:
    2.1. The static pressure set point as reset based on the valve requiring the most pressure; or
    2.2. Directly controlled based on zone hydronic demand; or
    2.3. Reset directly by an integral controller based on the relationship between variable speed controller frequency and power.

**C403.4.7 Combustion heating equipment controls.** Combustion heating equipment with a capacity over 225,000 Btu/h shall have modulating or staged combustion control.

**EXCEPTIONS:**

1. Boilers.
2. Radiant heaters.

**C403.4.7.1 Combustion decorative vented appliance, combustion 2 and fire pit controls.** Combustion decorative vented appliances, combustion fireplaces and fire pits shall be equipped with local controls to limit operation to a maximum duration of one hour without override hold capability or shall be controlled by occupancy sensor control configured with manual on and *automatic* shutoff within 15 minutes after occupants have left the space.

**C403.4.8 Group R-1 hotel/motel guestrooms.** See Section C403.7.4.

**C403.4.9 Group R-2 and R-3 dwelling units.** The primary space conditioning system within each *dwelling unit* shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the *dwelling unit* shall be provided with at least one adjustable thermostat for the regulation of temperature.

**EXCEPTIONS:**

1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than two hours.
3. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows:

1. When used to control heating only: 55°F to 75°F.
2. When used to control cooling only: 70°F to 85°F.
3. All other: 55°F to 85°F with an adjustable dead band configured to at least 5°F in accordance with Section C403.4.1.2.

**C403.4.10 Group R-2 sleeping units.** The primary space conditioning system within each sleeping unit shall be provided with at least one programmable thermostat for the regulation of space temperature. The thermostat shall allow for, at a

minimum, a 5-2 programmable schedule (weekdays/weekends) and be capable of providing at least two programmable setback periods per day.

Each additional system provided within the sleeping unit shall be provided with at least one adjustable thermostat for the regulation of temperature.

**EXCEPTIONS:**

1. Systems controlled by an occupant sensor that is configured to shut the system off when no occupant is sensed for a period of up to 30 minutes.
2. Systems controlled solely by a manually operated timer configured to operate the system for no more than two hours.
3. *Zones* with a full HVAC load demand not exceeding 3,400 Btu/h (1 kW) and having a manual shutoff switch located with ready access.
4. Ductless heat pumps.

Each thermostat shall be capable of being set by adjustment or selection of sensors and configured as follows:

1. When used to control heating only: 55°F to 75°F;
2. When used to control cooling only: 70°F to 85°F;
3. All other: 55°F to 85°F with an adjustable dead band configured to at least 5°F in accordance with Section C403.4.1.2.

**C403.4.11 Direct digital control systems.** Direct digital control (DDC) shall be required as specified in Sections C403.4.11.1 through C403.4.11.4.

**C403.4.11.1 DDC applications.** DDC shall be provided in the applications and qualifications listed in Table C403.4.11.1 and for load management measures where installed to meet the requirements of Section C406.3.

**C403.4.11.2 DDC controls.** Where DDC is required by Section C403.4.11.1, the DDC system shall be configured to perform all of the following functions, as required to provide the system and zone control logic required in Sections C403.2, C403.5, C403.6.8 and C403.4.3:

1. Monitor zone and system demand for fan pressure, pump pressure, heating and cooling.
2. Transfer zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers.

**C403.4.11.3 DDC display.** Where DDC is required by Section C403.4.11.1 for new buildings, the DDC system shall be configured to gather and provide trending data and graphically displaying input and output points.

**C403.4.11.4 DDC demand response setpoint adjustment.** Where DDC is required by Section C403.4.11.1 for new buildings and serve mechanical systems with a cooling capacity exceeding 780,000 Btu/h (2,662 kW), the *DDC system* shall be capable of demand response setpoint adjustment. The *DDC system* shall be configured with control logic to increase the cooling zone setpoints by at least 2°F (1°C) and reduce the heating zone setpoints 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.

**Table C403.4.11.1**
**DDC Applications and Qualifications**

| Building Status | Application | Qualifications |
|---|---|---|
| New building | Air-handling system and all zones served by the system | Individual systems supplying more than three zones and with fan system bhp of 10 hp and larger |
| | Chilled-water plant and all coils and terminal units served by the system | Individual plants supplying more than three zones and with design cooling capacity of 300,000 Btu/h and larger |
| | Hot-water plant and all coils and terminal units served by the system | Individual plants supplying more than three zones and with design heating capacity of 300,000 Btu/h and larger |

**Table C403.4.11.1—continued**
**DDC Applications and Qualifications**

| Building Status | Application | Qualifications |
|---|---|---|
| Alteration or addition | Zone terminal unit such as VAV box | Where existing zones served by the same air-handling, chilled-water, or hot-water system have DDC |
| | Air-handling system or fan coil | Where existing air-handling system(s) and fan coil(s) served by the same chilled- or hot-water plant have DDC |
| | New air-handling system and all new zones served by the system | Individual systems with fan system bhp of 10 hp and larger and supplying more than three zones and more than 75 percent of zones are new |
| | New or upgraded chilled-water plant | Where all chillers are new and plant design cooling capacity is 300,000 Btu/h and larger |
| | New or upgraded hot-water plant | Where all boilers are new and plant design heating capacity is 300,000 Btu/h and larger |

**C403.4.12 Pressure independent control valves.** Where design flow rate of heating water and chiller water coils is 5 gpm or higher, modulating pressure independent control valves shall be provided.

**C403.5 Economizers.** Air economizers shall be provided on all new cooling systems including those serving computer server rooms, electronic equipment, radio equipment, and telephone switchgear. Economizers shall comply with Sections C403.5.1 through C403.5.5.

**EXCEPTIONS:**

1a. For other than Group R-2 occupancies, cooling system where the supply fan is not installed outside the *building thermal envelope* nor in a *mechanical room* adjacent to outdoors, and is installed in conjunction with DOAS complying with Section C403.3.5 and serving only spaces with year-round cooling loads from lights and equipment of less than 5 watts per square foot.

1b. For Group R-2 occupancies, cooling system where the supply fan is not installed outside the *building thermal envelope* nor in a *mechanical room* adjacent to outdoors, and is installed in conjunction with DOAS complying with Section C403.3.5, where the ERV/HRV has a minimum ((~~68~~)) 67 percent sensible recovery or 60 percent enthalpy recovery heating effectiveness, (((~~Exception 3 of Section C403.3.5.1 is not utilized),~~)) and serving only spaces with year-round cooling loads from lights and equipment of less than 5 watts per square foot.

2. Unitary or packaged systems serving one zone with dehumidification ((~~that affect other systems so as to~~)) where an air economizer would increase the overall building energy consumption. New humidification equipment shall comply with Section C403.3.2.7.

3. Unitary or packaged systems serving one zone where the cooling efficiency meets or exceeds the efficiency requirements in Table C403.5(3).

4. Equipment serving chilled beams and chilled ceiling space cooling systems only which are provided with a water economizer meeting the requirements of Section C403.5.4.

5. For Group R occupancies, cooling unit where the supply fan is not installed outside the *building thermal envelope* or in a *mechanical room* adjacent to outdoors with a total cooling capacity less than 20,000 Btu/h and other cooling units with a total cooling capacity less than 54,000 Btu/h provided that these are high-efficiency cooling equipment with IEER, CEER, SEER, and EER values more than 15 percent higher than minimum efficiencies listed in Tables C403.3.2(1), C403.3.2(2), C403.3.2(4), C403.3.2(8) and C403.3.2(9) or an IPLV kW/ton that is at least 15 percent lower than the minimum efficiencies listed in Table C403.3.2(3) or C403.3.2(15), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. For split systems, compliance is based on the cooling capacity of individual fan coil units.

6. Equipment used to cool *Controlled Plant Growth Environments* provided these are high-efficiency cooling equipment with SEER, EER and IEER values a minimum of 20 percent greater than the values listed in Tables C403.3.2 (1), (3), (4), and (15).

7. Equipment serving a space with year-round cooling loads from lights and equipment of 5 watts per square foot or greater complying with the following criteria:

7.1. Equipment serving the space utilizes chilled water as the cooling source; and

7.2. The chilled water plant includes a condenser heat recovery system that meets the requirements of Section ((~~C403.9.5~~)) C403.9.2.1 or the building and water-cooled system meets the following requirements:

7.2.1. A minimum of 90 percent (capacity-weighted) of the building space heat is provided by hydronic heating water.

7.2.2. Chilled water plant includes a heat recovery chiller or water-to-water heat pump capable of rejecting heat from the chilled water system to the hydronic heating equipment capacity.

7.2.3. Heat recovery chillers shall have a minimum COP of 7.0 when providing heating and cooling water simultaneously.

8. Water-cooled equipment served by systems meeting the requirements of Section C403.9.2.4 Condenser heat recovery.

9. Dedicated outdoor air systems that include energy recovery as required by Section C403.7.6 but that do not include mechanical cooling.

10. Dedicated outdoor air systems not required by Section C403.7.6 to include energy recovery that modulate the supply airflow to provide only the minimum outdoor air required by Section C403.2.2.1 for ventilation, exhaust air make-up, or other process air delivery.

((~~9~~)) 11. Equipment used to cool any dedicated server room, electronic equipment room, elevator machine room or telecom switch room provided the system complies with Option a, b, ((~~or~~)) c, d or e in ((~~the table~~)) Table C403.5(9) below. The total cooling capacity of all fan systems qualifying under this exception 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 or Target Performance Path compliance.

((~~10. Dedicated outdoor air systems that include energy recovery as required by Section C403.7.6 but do not include mechanical cooling.~~

~~11. Dedicated outdoor air systems not required by Section C403.7.6 to include energy recovery that modulate the supply airflow to provide only the minimum outdoor air required by Section C403.2.2.1 for ventilation, exhaust air make-up, or other process air delivery.~~))

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

**Table C403.5(9)**
**Server room, electronic equipment room or telecom room cooling equipment**

| | Equipment Type | Higher Equipment Efficiency | Part-Load Control | Economizer |
|---|---|---|---|---|
| Option a | Tables C403.3.2(1), C403.3.2(2) and C403.3.2(14)[a] | +15%[b] | Required over 85,000 Btu/h[c] | None Required |
| Option b | Tables C403.3.2(1), C403.3.2(2) and C403.3.2(14)[a] | +5%[d] | Required over 85,000 Btu/h[c] | Waterside Economizer[e] |
| Option c | ASHRAE Standard 127[f] | +0%[g] | Required over 85,000 Btu/h[c] | Waterside Economizer[e] |
| Option d | Table C403.3.2(7)[h] | + 25%[i] | Required for all chillers[i] | None Required |
| Option e | Table C403.3.2(7)[h] | + 10/15%[k] | Required over 85,000 Btu/h[c] | Dedicated waterside Economizer[e] |

Footnotes for Table C403.5(9):

a For a system where all of the cooling equipment is subject to the AHRI standards listed in Tables C403.3.2(1), C403.3.2(2), and C403.3.2 (14), the system shall comply with ((~~all of the following~~)) the higher equipment efficiency, part-load control and economizer requirements of the row in which this footnote is located, including the associated footnotes (note that if the system contains any cooling equipment that exceeds the capacity limits in Table C403.3.2(1), C403.3.2(2), or C403.3.2 (14), or if the system contains any cooling equipment that is not included in Table C403.3.2(1), C403.3.2(2), or C403.3.2 (14), then the system is not allowed to use this option).

b The cooling equipment shall have a SEER/EER value and an IEER/IPLV value that each is a minimum of 15 percent greater than the value listed in Tables C403.3.2(1), C403.3.2(2), and C403.3.2 (14).

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 a SEER/EER value and an IEER/IPLV value that each is a minimum of 5 percent greater than the value listed in Tables C403.3.2(1), C403.3.2(2), and C403.3.2 (14).

e The system shall include a water economizer in lieu of air economizer. Water economizers shall meet the requirements of C403.5.1 and C403.5.2 and be capable of providing the total concurrent cooling load served by the connected terminal equipment lacking airside economizer, at outside air temperatures of 50°F dry-bulb/45°F wet-bulb and below. For this calculation, all factors including solar and internal load shall be the same as those used for peak load calculations, except for the outside temperatures. The equipment shall be served by a dedicated condenser water system unless a nondedicated condenser water system exists that can provide appropriate water temperatures during hours when waterside economizer cooling is available.

f For a system where all cooling equipment is subject to ASHRAE Standard 127, the system shall comply with the higher equipment efficiency, part-load control, and economizer requirements of the row in which this footnote is located, including the associated footnotes.

g The cooling equipment subject to the ASHRAE Standard 127 shall have an ((~~EER value and an IPLV~~)) SCOP value that is ((~~equal or~~)) a minimum of 10 percent greater than the value listed in Tables C403.3.2(1), C403.3.2(2), and C403.3.2 (14) (1.10 × 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 C403.3.2(7) (as an example, a chilled water system with fan coil units), the system shall comply with the higher equipment efficiency, part-load control and economizer requirements of the row in which this footnote is located, including the associated footnotes.

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 C403.3.2(7) (1.25 × value in Table C403.3.2(7) or a full-load and IPLV kW/ton that is at least 25 percent lower than the value listed in Table C403.3.2(7) (0.75 × value in Table C403.3.2(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 C403.3.2(7) (1.10 × values in Table C403.3.2(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 C403.3.2(7) (0.85 × values in Table C403.3.2(7)).

**Table C403.5(3)**
**Equipment Efficiency Performance**

| Climate Zones | Efficiency Improvement[a] |
|---|---|
| 4C | 64% |
| 5B | 59% |

[a] If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling, then these must be increased by the percentage shown.

**C403.5.1 Integrated economizer control.** Economizer systems shall be integrated with the mechanical cooling system and be configured to provide partial cooling even where additional mechanical cooling is required to provide the remainder of the cooling load. Controls shall not be capable of creating a false load in the mechanical cooling system by limiting or disabling the economizer or any other means, such as hot gas bypass, except at the lowest stage of mechanical cooling.

Units that include an *air economizer* shall comply with the following:

1. Unit controls shall have the mechanical cooling capacity control interlocked with the *air economizer* controls such that the outdoor air damper is at the 100 percent open position when mechanical cooling is on and the outdoor air damper does not begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 45°F (7°C).
2. Direct expansion (DX) units with cooling capacity 65,000 Btu/H (19 kW) or greater of rated capacity shall comply with the following:
    2.1. DX units that control the capacity of the mechanical cooling directly based on occupied space temperature shall have not fewer than two stages of mechanical cooling capacity.
    2.2. Other DX units, including those that control space temperature by modulating the airflow to the space, shall be in accordance with Table C403.5.1.

**TABLE C403.5.1**
**DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITS**

| Rating Capacity | Minimum Number of Mechanical Cooling Stages | Minimum Compressor Displacement[a] |
|---|---|---|
| ≥ 65,000 Btu/h and < 240,000 Btu/h | 3 stages | ≤ 35% of full load |
| ≥ 240,000 Btu/h | 4 stages | ≤ 25% of full load |

For SI: 1 Btu/h = 0.2931 W

a. For *mechanical cooling* stage control that does not use variable compressor displacement, the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

**C403.5.2 Economizer heating system impact.** HVAC system design and economizer controls shall be such that economizer operation does not increase building heating energy use during normal operation.

**EXCEPTION:** Economizers on VAV systems that cause *zone* level heating to increase due to a reduction in supply air temperature.

**C403.5.3. Air economizers.** *Air economizers* shall comply with Sections C403.5.3.1 through C403.5.3.5.

**C403.5.3.1 Design capacity.** *Air economizer* systems shall be configured to modulate *outdoor air* and return air dampers to provide up to 100 percent of the design supply air quantity as *outdoor air* for cooling.

**C403.5.3.2 Control signal.** Economizer controls and dampers shall be configured to sequence the dampers with mechanical cooling equipment and shall not be controlled by only mixed air temperature. *Air economizers* on systems with cooling capacity greater than 65,000 Btu/h shall be configured to provide partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

**C403.6.4 Supply-air temperature reset controls.** Multiple *zone* HVAC systems shall include controls that are capable of and configured to automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperature. The controls shall be configured to reset the supply air temperature at least 25 percent of the difference between the design supply-air temperature and the design room air temperature. Controls that adjust the reset based on zone humidity are allowed. HVAC zones that are expected to experience relatively constant loads shall have maximum airflow designed to accommodate the fully reset supply air temperature.

**EXCEPTIONS:**

1. Systems that prevent reheating, recooling or mixing of heated and cooled supply air.
2. Seventy-five percent of the energy for reheating is from a site-recovered source.

**C403.6.5 Multiple-zone VAV system ventilation optimization control.** Multiple-zone VAV systems with direct digital control of individual zone boxes reporting to a central control panel shall have automatic controls configured to reduce outdoor air intake flow below design rates in response to changes in system ventilation efficiency ($E_v$) as defined by the *International Mechanical Code*.

**EXCEPTIONS:**

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

**C403.6.6 Parallel-flow fan-powered VAV air terminal control.** Parallel-flow fan-powered VAV air terminals shall have automatic controls configured to:

1. Turn off the terminal fan except when space heating is required or where required for ventilation.
2. Turn on the terminal fan as the first stage of heating before the heating coil is activated.
3. During heating for warmup or setback temperature control, either:
   3.1. Operate the terminal fan and heating coil without primary air.
   3.2. Reverse the terminal damper logic and provide heating from the central air handler by primary air.

**C403.6.7 Reserved.**

**C403.6.8 Set points for direct digital control.** For systems with direct digital control of individual *zones* reporting to the central control panel, the static pressure setpoint shall be reset based on the *zone* requiring the most pressure. In such cases, the set point is reset lower until one zone damper is nearly wide open. The direct digital controls shall be capable of monitoring zone damper positions or shall have an alternative method of indicating the need for static pressure that is configured to provide all of the following:

1. Automatically detecting any zone that excessively drives the reset logic.
2. Generating an alarm to the system operational location.
3. Allowing an operator to readily remove one or more zones from the reset algorithm.

**C403.6.9 Static pressure sensor location.** Static pressure sensors used to control VAV fans shall be located such that the controller setpoint is no greater than 1.2 inches w.c. (299 Pa). Where this results in one or more sensors being located downstream of major duct splits, not less than one sensor shall be located on each major branch to ensure that static pressure can be maintained in each branch.

**EXCEPTION:** Systems complying with Section C403.6.8.

**C403.6.10 High efficiency variable air volume (VAV) systems.** For HVAC systems subject to the requirements of Section C403.3.5 but utilizing Exception 2 of that section, a high efficiency multiple-zone VAV system may be provided without a separate parallel DOAS when the system is designed, installed, and configured to comply with all of the following criteria (this exception shall not be used as a substitution for a DOAS per Section C406.6):

1. Each VAV system must serve a minimum of 3,000 square feet (278.7 $m^2$) and have a minimum of five VAV zones.
2. The VAV systems are provided with airside economizer per Section C403.5 without exceptions.
3. A direct-digital control (DDC) system is provided to control the VAV air handling units and associated terminal units per Section C403.4.11 regardless of sizing thresholds of Table C403.4.11.1.
4. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the outdoor airflow intake based on feedback from the VAV terminal units as required by Section C403.6.5, without exceptions, and Section C403.7.1 demand controlled ventilation.

5. Multiple-zone VAV systems with a minimum outdoor air requirement of 2,500 cfm (1180 L/s) or greater shall be equipped with a device capable of measuring supply airflow to the VAV terminal units under all load conditions.
6. In addition to meeting the zone isolation requirements of C403.2.1 a single VAV air handling unit shall not serve more than 50,000 square feet (4645 $m^2$) unless a single floor is greater than 50,000 square feet (4645 $m^2$) in which case the air handler is permitted to serve the entire floor.
7. The primary maximum cooling air for the VAV terminal units serving interior cooling load driven zones shall be sized for a supply air temperature that is a minimum of 5°F greater than the supply air temperature for the exterior zones in cooling.
8. Air terminal units with a minimum primary airflow setpoint of 50 percent or greater of the maximum primary airflow setpoint shall be sized with an inlet velocity of no greater than 900 feet per minute. ((~~Allowable fan motor horsepower shall not exceed 90 percent of the allowable HVAC~~ *~~fan system bhp~~* ~~(Option 2) as defined by Section C403.8.1.1.~~))
9. ((~~Allowable fan power shall not exceed 90 percent of the allowable fan power budget as defined by Section C403.8.1.1.~~)) *Fan system electrical input power* (Fan $kW_{design,system}$) shall not exceed 90 percent of the fan power budget (Fan $kW_{budget}$) as defined by Section C403.8.1.
10. All fan powered VAV terminal units (series or parallel) shall be provided with electronically commutated motors. The DDC system shall be configured to vary the speed of the motor as a function of the heating and cooling load in the space. Minimum speed shall not be greater than 66 percent of design airflow required for the greater of heating or cooling operation. Minimum speed shall be used during periods of low heating and cooling operation and ventilation-only operation.

    **EXCEPTION:** For series fan powered terminal units where the volume of primary air required to deliver the ventilation requirements at minimum speed exceeds the air that would be delivered at the speed defined above, the minimum speed setpoint shall be configured to exceed the value required to provide the required ventilation air.
11. Fan-powered VAV terminal units shall only be permitted at perimeter zones with an envelope heating load requirement. All other VAV terminal units shall be single duct terminal units.

    **EXCEPTION:** Fan powered VAV terminal units are allowed at interior spaces with an occupant load greater than or equal to 25 people per 1000 square feet of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) with demand control ventilation in accordance with Section C403.7.1.
12. When in occupied heating or in occupied deadband between heating and cooling all fan powered VAV terminal units shall be configured to reset the primary air supply setpoint, based on the VAV air handling unit outdoor air vent fraction, to the minimum ventilation airflow required per *International Mechanical Code*.
13. Spaces that are larger than 150 square feet (14 $m^2$) and with an occupant load greater than or equal to ((~~25~~)) 15 people per 1000 square feet (93 $m^2$) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:
    13.1. A dedicated VAV terminal unit capable of controlling the space temperature and minimum ventilation shall be provided.
    13.2. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the VAV terminal unit from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.
    13.3. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.
14. Dedicated data centers, computer rooms, electronic equipment rooms, telecom rooms, or other similar spaces with cooling loads greater than 5 watts/sf shall be provided with separate cooling systems to allow the VAV air handlers to turn off during unoccupied hours in the office space and to allow the supply air temperature reset to occur.

    **EXCEPTION:** The VAV air handling unit and VAV terminal units may be used for secondary backup cooling when there is a failure of the primary HVAC system.

Additionally, computer rooms, electronic equipment rooms, telecom rooms, or other similar spaces shall be provided with airside economizer in accordance with Section 403.5 without using the exceptions to Section C403.5.

**EXCEPTION:** Heat recovery per Exception 9 of Section C403.5 may be in lieu of airside economizer for the separate, independent HVAC system.

15. HVAC system central heating or cooling plant will include a minimum of one of the following options:
    15.1. VAV terminal units with hydronic heating coils connected to systems with hot water generation equipment limited to the following types of equipment: ((~~Gas-fired hydronic boilers with a thermal efficiency, $E_t$, of~~

~~not less than 92 percent,~~)) air-to-water heat pumps, ground-source water-to-water heat pumps, wastewater heat recovery water-to-water heat pumps, or heat recovery chillers. Hydronic heating coils shall be sized for a maximum entering hot water temperature of 120°F (48.9°C) for peak anticipated heating load conditions.

15.2. Chilled water VAV air handing units connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than the minimum part load efficiencies listed in Table C403.3.2(3), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20 percent of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20 percent of the total central cooling plant capacity.

16. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:

16.1. The following temperature sensors shall be permanently installed to monitor system operation:

16.1.1. Outside air.

16.1.2. Supply air.

16.1.3. Return air.

16.2. Temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of 40°F to 80°F (4°C to 26.7°C).

16.3. The VAV air handling unit controller shall be configured to provide system status by indicating the following:

16.3.1. Free cooling available.

16.3.2. Economizer enabled.

16.3.3. Compressor enabled.

16.3.4. Heating enabled.

16.3.5. Mixed air low limit cycle active.

16.3.6. The current value of each sensor.

16.4. The VAV air handling unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.

16.5. The VAV air handling unit shall be configured to report faults to a fault management application able to be accessed by day-to-day operating or service personnel or annunciated locally on zone thermostats.

16.6. The VAV terminal unit shall be configured to report if the VAV inlet valve has failed by performing the following diagnostic check at a maximum interval of once a month:

16.6.1. Command VAV terminal unit primary air inlet valve closed and verify that primary airflow goes to zero or other *approved* means to verify that the VAV terminal unit damper actuator and flow ring are operating properly.

16.6.2. Command VAV terminal unit primary air inlet valve to design airflow and verify that unit is controlling to within 10 percent of design airflow.

16.7. The VAV terminal unit shall be configured to report and trend when the zone is driving the following VAV air handling unit reset sequences. The building operator shall have the capability to exclude zones used in the reset sequences from the DDC control system graphical user interface:

16.7.1. Supply air temperature setpoint reset to lowest supply air temperature setpoint for cooling operation.

16.7.2. Supply air duct static pressure setpoint reset for the highest duct static pressure setpoint allowable.

16.8. The FDD system shall be configured to detect the following faults:

16.8.1. Air temperature sensor failure/fault.

16.8.2. Not economizing when the unit should be economizing.

16.8.3. Economizing when the unit should not be economizing.

16.8.4. Outdoor air or return air damper not modulating.

16.8.5. Excess outdoor air.

16.8.6. VAV terminal unit primary air valve failure.

**C403.7.3 Ventilation air heating control.** For ventilation air units with supplemental heating capacity that operate in conjunction with zone heating and cooling systems, supplemental heating shall not warm ventilation supply air to a temperature greater than 55°F (13°C).

**C403.7.4 Automatic control of HVAC systems serving guestrooms.** In Group R-1 buildings containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.4.1 and C403.7.4.2. Card key controls comply with these requirements.

**C403.7.4.1 Temperature setpoint controls.** Controls shall be provided on each HVAC system that are capable of and configured with three modes of temperature control.

1. When the guestroom is rented but unoccupied, the controls shall automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom.
2. When the guestroom is unrented and unoccupied, the controls shall automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C). Unrented and unoccupied guestroom mode shall be initiated within 16 hours of the guestroom being continuously occupied or where a *networked guestroom control system* indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. A *networked guestroom control system* that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65 percent relative humidity during unoccupied periods is not precluded by this section.
3. When the guestroom is occupied, HVAC set points shall return to their occupied set point once occupancy is sensed.

**C403.7.4.2 Ventilation controls.** Controls shall be provided on each HVAC system that are capable of and configured to automatically turn off the ventilation and exhaust fans within 20 minutes of the occupants leaving the guestroom or isolation devices shall be provided to each guestroom that are capable of automatically shutting off the supply of outdoor air to and exhaust air from the guestroom.

**EXCEPTION:** Guestroom ventilation systems are not precluded from having an automatic daily preoccupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

**C403.7.5 Loading dock, motor vehicle repair garage, and parking garage ventilation system controls.** Mechanical ventilation systems for 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 by means of carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors. Controllers shall be configured to shut off fans or modulate fan speed to 20 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with the *International Mechanical Code* provisions.

Ventilation systems with total ventilation system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fan system design conditions and those with heating and/or cooling shall have controls and devices that modulate fan speed and result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow.

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. Parking garages, repair garages, and loading docks shall be equipped with a controller and a full array of carbon monoxide (CO) sensors set to maintain levels of carbon monoxide below 35 parts per million (ppm). Additionally, a full array of nitrogen dioxide detectors shall be connected to the controller set to maintain the nitrogen dioxide level below the OSHA standard for eight hour exposure.

Spacing and location of the sensors shall be installed in accordance with manufacturer recommendations.

**C403.7.5.1 System activation devices for loading docks.** Ventilation systems for enclosed loading docks shall operate continuously during unoccupied hours at 50 percent or less of design capacity 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*, Section 404; or
2. Occupant detection sensors used to activate the system that detects entry into the loading area along both the vehicle and pedestrian pathways.

**C403.7.5.2 System activation devices for parking garages.** Ventilation systems for enclosed parking garages shall be activated by gas sensors to activate the full required ventilation rate in accordance with the *International Mechanical Code*, Section 404.

**C403.7.6 Energy recovery ventilation systems.** Energy recovery ventilation systems shall be provided as specified in Sections C403.7.6.1 and C403.7.6.2.

**C403.7.6.1 Ventilation for Group R-2 occupancy.** For all Group R-2 dwelling and sleeping units, a balanced ventilation system with heat recovery system with minimum ((~~60~~)) 67 percent sensible recovery effectiveness shall provide outdoor air directly to each habitable space in accordance with the *International Mechanical Code*. The ventilation system shall allow for the design flow rates to be tested and verified at each habitable space as part of the commissioning process in accordance with Section C408.2.2. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C), or as calculated by the *registered design professional*.

**EXCEPTION:** Heat recovery and energy recovery ventilators (H/ERVs) that are rated and listed in accordance with HVI 920 can demonstrate compliance with the sensible recovery effectiveness requirement using the sensible recovery effectiveness (ASRE) rating of the equipment at 32°F test conditions. Applied flow rate for ASRE rating shall be no less than the design flow rate or the closest value interpolated between two listed flow rates.

**C403.7.6.2 Spaces other than Group R-2 dwelling or sleeping units.** Any system serving a space other than a Group R-2 dwelling or sleeping unit with minimum ((~~outside~~)) outdoor air requirements at design conditions greater than 5,000 cfm or any system where the system's supply airflow rate exceeds the value listed in Tables C403.7.6(1) and C403.7.6(2), based on the climate zone and percentage of outdoor airflow rate at design conditions, shall include an energy recovery system. Table C403.7.6(1) shall be used for all ventilation systems that operate less than 8,000 hours per year, and Table C403.7.6(2) shall be used for all ventilation systems that operate 8,000 hours or more per year. The energy recovery system shall provide a ((~~68~~)) 67 percent minimum sensible recovery effectiveness or have an *enthalpy recovery ratio* of not less than 60 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass of the energy recovery media for both the outdoor air and exhaust air or return air dampers and controls which permit operation of the air economizer as required by Section C403.5. Where a single room or space is supplied by multiple units, the aggregate ventilation (cfm) of those units shall be used in applying this requirement. The return/exhaust air stream temperature for heat recovery device selection shall be 70°F (21°C) at 30 percent relative humidity, or as calculated by the registered design professional.

**SDCI Informative Note:** In Seattle, the energy recovery effectiveness is determined typically by the winter heat recovery condition. See example below for how the minimum supply air enthalpy leaving the energy recovery media is calculated for the winter condition:

1. In Seattle, the winter outdoor design air temperature is 24°F as specified in Appendix C. The registered design professional shall determine the coincident winter wet bulb temperature or percent relative humidity at the anticipated design conditions. Based on these conditions the outdoor design air enthalpy is determined from a psychrometric chart.
2. Determine the return/exhaust air stream enthalpy from a psychrometric chart based on the 70°F (21°C) at 30 percent relative humidity.
3. Calculate the 60% difference between the outside air and return air enthalpies at design winter conditions.
4. See example below:
   a. OA Enthalpy at 24°F/23°F (drybulb/wetbulb) = 8.2 BTU/LB
   b. RA/EA Enthalpy at 70°F and 30% RH = 21.9 BTU/LB
   c. SA Enthalpy Minimum Leaving Energy Recovery Media
      = (8.2 + (21.9 - 8.2)*60%)
      = 16.42 BTU/LB

(Note that this example represents 60% enthalpy recovery. For an equivalent sensible-only recovery system, it would take 73.9% effectiveness (increasing from 24°F DB to 58°F DB) to achieve the same enthalpy recovery.)

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

1. Where energy recovery systems are restricted per Section 514 of the *International Mechanical Code* to sensible energy recovery, the system shall comply with one of the following:
   1.1. Kitchen exhaust systems where they comply with Section C403.7.7.1.
   1.2. Laboratory fume ((~~hood~~)) exhaust systems where they comply with ((~~Exception 2 of Section C403.7.6~~)) Section C403.7.7.2.
   1.3. Other sensible energy recovery systems with the capability to provide a change in dry-bulb temperature of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and the return air dry-bulb temperatures, at design conditions. Where an air economizer is required, the energy

recovery system shall include a bypass of the energy recovery media for both the outdoor air and exhaust air.

2. Buildings with laboratory fume ((~~hood~~)) exhaust systems having a total exhaust rate less than or equal to 5,000 cfm (2360 L/s) ((~~that~~)) shall include at least one of the following features ((~~and also~~)) or shall comply with Section C403.7.7.2:
   2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   2.2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (1.1°C) above room setpoint, cooled to no cooler than 3°F (1.7°C) below room setpoint, no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and are not cooled.
4. Where more than 60 percent of the outdoor air heating energy is provided from site-recovered energy.
5. Systems exhausting hazardous, toxic, flammable, paint or corrosive fumes or dust. This exception may not be used for laboratory fume exhaust systems required to comply with Exception 2 of Section C403.7.6 or Section C403.7.7.2 without approval of the code official.
6. Cooling energy recovery.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Multiple-zone systems where the supply airflow rate is less than the values specified in Tables C403.7.6 (1) and (2), for the corresponding percent of outdoor air. Where a value of NR is listed, energy recovery shall not be required.
9. Equipment which meets the requirements of Section C403.9.2.4.
10. Systems serving Group R-1 dwelling or sleeping units where the largest source of air exhausted at a single location at the building exterior is less than 25 percent of the design outdoor air flow rate.
11. Systems serving Ambulatory Care Facilities and Group I-2 Occupancies ventilated in accordance with Section 407 of the *International Mechanical Code*, systems exhausting environmental exhaust air in research or education laboratory spaces complying with the Seattle Director's Rule alternate of Section 510 of the International Mechanical Code, and systems exhausting environmental exhaust air in spaces that have Hazardous Exhaust Systems complying with Section 510 of the *International Mechanical Code*, are permitted to provide a 60 percent minimum sensible heat recovery effectiveness or have an enthalpy heat recovery ratio of not less than 50 percent at design conditions. Where an air economizer is required, the energy or heat recovery system shall include a bypass of the energy or heat recovery media for both the outdoor air and exhaust air.

**Table C403.7.6(1)**
**Energy Recovery Requirement**

| Percent (%) Outdoor Air at Full Design Airflow Rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Climate zone | ≥ 10% and < 20% | ≥ 20% and < 30% | ≥ 30% and < 40% | ≥ 40% and < 50% | ≥ 50% and < 60% | ≥ 60% and < 70% | ≥ 70% and < 80% | ≥ 80% |
| Design Supply Fan Airflow Rate (cfm) | | | | | | | | |
| 4C, 5B | NR | NR | NR | NR | NR | NR | ≥ 5000 | ≥ 5000 |

NR = Not required.

**Table C403.7.6(2)**
**Energy Recovery Requirement**

| Percent (%) Outdoor Air at Full Design Airflow Rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Climate zone | ≥ 10% and < 20% | ≥ 20% and < 30% | ≥ 30% and < 40% | ≥ 40% and < 50% | ≥ 50% and < 60% | ≥ 60% and < 70% | ≥ 70% and < 80% | ≥ 80% |
| Design Supply Fan Airflow Rate (cfm) | | | | | | | | |
| 4C | NR | ≥ 19500 | ≥ 9000 | ≥ 5000 | ≥ 4000 | ≥ 3000 | ≥ 1500 | ≥ 120 |
| 5B | ≥ 2500 | ≥ 2000 | ≥ 1000 | ≥ 500 | ≥ 140 | ≥ 120 | ≥ 100 | ≥ 80 |

NR = Not required.

### C403.7.7 Exhaust systems.

#### C403.7.7.1 Kitchen exhaust systems.

**C403.7.7.1.1 Replacement air.** Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate.

**C403.7.7.1.2 Kitchen exhaust hood certification and maximum airflow.** Where a kitchen or kitchen/dining facility has a total kitchen hood exhaust airflow rate that is greater than 2,000 cfm, each hood shall be a factory built commercial exhaust hood listed by a nationally recognized testing laboratory in compliance with UL 710 and each hood shall have a maximum exhaust rate as specified in Table C403.7.7.1.2. Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

**EXCEPTION:** Type II dishwasher exhaust hoods that have an exhaust airflow of 1000 cfm or less.

**Table C403.7.7.1.2**
**Maximum Net Exhaust Flow Rate, CFM Per Linear Foot of Hood Length**

| Type of Hood | Light-duty Equipment | Medium-duty Equipment | Heavy-duty Equipment | Extra-heavy-duty Equipment |
|---|---|---|---|---|
| Wall-mounted canopy | 140 | 210 | 280 | 385 |
| Single island | 280 | 350 | 420 | 490 |
| Double island (per side) | 175 | 210 | 280 | 385 |
| Eyebrow | 175 | 175 | NA | NA |
| Backshelf/pass-over | 210 | 210++++ | 280 | NA |

For SI: 1 cfm = 0.4719 L/s; 1 foot = 305 mm
NA = Not allowed

**C403.7.7.1.3 Kitchen exhaust hood system.** Kitchen exhaust hood systems serving Type I exhaust hoods shall be provided with *demand control kitchen ventilation* (DCKV) controls where a kitchen or kitchen/dining facility has a total kitchen hood exhaust airflow rate greater than 2000 cfm. DCKV systems shall be configured to provide a minimum of 50 percent reduction in exhaust and replacement air system airflows in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle operation.

**EXCEPTIONS:**

1. UL 710 listed exhaust hoods that have a design maximum exhaust airflow rate no greater than 250 cfm per linear foot of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 5000 cfm.
2. An energy recovery device is installed on the kitchen exhaust with a sensible heat recovery effectiveness of not less than 40 percent or not less than 50 percent of the total exhaust hood airflow.

**C403.7.7.2 Laboratory <u>fume</u> exhaust systems.** Buildings with laboratory <u>fume</u> exhaust systems having a total exhaust rate greater than 5,000 cfm (2360 L/s) shall include heat recovery systems to precondition replacement air from laboratory <u>fume</u> exhaust. The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 25°F (13.9°C). A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section C403.5.

**EXCEPTIONS:**

1. Variable air volume laboratory <u>fume</u> exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values; or
2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the <u>fume</u> exhaust rate, heated no warmer than 2°F (1.1°C) below room setpoint, cooled to no cooler than 3°F (1.7°C) above room setpoint, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or
3. Combined energy reduction method: VAV <u>fume</u> exhaust and room supply system configured to reduce <u>fume</u> exhaust and makeup air volumes and a heat recovery system to precondition makeup air from laboratory <u>fume</u> exhaust that when combined will produce the same energy reduction as achieved by a heat recovery system with a 50 percent sensible recovery effectiveness as required above. For calculation purposes, the heat recovery component can be assumed to include the maximum design supply airflow rate at design conditions. The combined energy reduction ($Q_{ER}$) shall meet the following:

$$Q_{ER} \geq Q_{MIN}$$

$$Q_{MIN} = CFM_S \bullet (T_R - T_O) \bullet 1.1 \bullet 0.6$$

$$Q_{ER} = CFM_S \bullet (T_R - T_O) \bullet 1.1(A + B)/100$$

Where:

$Q_{MIN}$ = Energy recovery at 60 percent sensible effectiveness (Btu/h)

$Q_{ER}$ = Combined energy reduction (Btu/h)

$CFM_S$ = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute

$T_R$ = Space return air dry-bulb at winter design conditions

$T_O$ = Outdoor air dry-bulb at winter design conditions

A = Percentage that the exhaust and makeup air volumes can be reduced from design conditions

B = Percentage sensible heat recovery effectiveness

**C403.7.7.3 Transfer air.** Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of:

1. The supply flow required to meet the space heating or cooling load;
2. The ventilation rate required by the authority having jurisdiction, the facility environmental health and safety department, or Section C403.2.2; or
3. The mechanical exhaust flow minus the available transfer air from conditioned spaces or return air plenums that at their closest point are within 15 feet of each other on the same floor that are not in different smoke or fire compartments. Available transfer air is that portion of outdoor ventilation air that:
   3.1. Is not required to satisfy other exhaust needs;
   3.2. Is not required to maintain pressurization of other spaces; and
   3.3. Is transferable according to applicable codes and standards and per the *International Mechanical Code*.

**EXCEPTIONS:**

1. Laboratories classified as biosafety level 3 or higher.
2. Vivarium spaces.
3. Spaces that are required by applicable codes and standards to be maintained at positive pressure relative to adjacent spaces. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.
4. Spaces where the demand for transfer air may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.

**C403.7.8 Shutoff dampers.** Mechanical openings shall be provided with shutoff dampers in accordance with Sections C403.7.8.1 through C403.7.8.4.

**C403.7.8.1 Shutoff dampers for building isolation.** Outdoor air supply, exhaust openings and relief outlets and stairway and elevator hoistway shaft vents shall be provided with Class I motorized dampers. See Sections C403.10.1 and C403.10.2 for ductwork insulation requirements upstream and downstream of the shutoff damper.

**EXCEPTIONS:**

1. Gravity (nonmotorized) dampers shall be permitted in lieu of motorized dampers as follows:
   1.1. Relief dampers serving systems less than ((~~5,000~~)) 300 cfm total supply shall be permitted ((~~in buildings less than three stories in height.~~))
   1.2. Gravity (nonmotorized) dampers where the design outdoor air intake or exhaust capacity does not exceed 300 cfm (142 L/s).
   1.3. Systems serving areas which require continuous operation for 24/7 occupancy schedules.
2. Shutoff dampers are not required in:
   2.1. Combustion air intakes.

2.2. Systems serving areas which require continuous operation in animal hospitals, kennels and pounds, laboratories, and Group H, I and R occupancies.

2.3. Subduct exhaust systems or other systems that are required to operate continuously by the *International Mechanical Code*.

2.4. Type I grease exhaust systems or other systems where dampers are prohibited by the *International Mechanical Code* to be in the airstream.

2.5. Unconditioned stairwells or unconditioned elevator hoistway shafts that are only connected to unconditioned spaces.

**C403.7.8.2 Shutoff dampers for return air.** Return air openings used for airside economizer operation shall be equipped with Class I motorized dampers.

**C403.7.8.3 Damper leakage rating.** Class 1 dampers shall have a maximum leakage rate of 4 cfm/ft$^2$ (20.3 L/s × m$^2$) at 1.0 inch water gauge (w.g.) (249 Pa) when tested in accordance with AMCA 500D and shall be labeled by an approved agency for such purpose. Gravity (nonmotorized) dampers shall have an air leakage rate not greater than 20 cfm/ft$^2$ where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft$^2$ where less than 24 inches in either dimension. The rate of air leakage shall be determined at 1.0 inch w.g. (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an approved agency. Gravity dampers for ventilation air intakes shall be protected from direct exposure to wind.

**EXCEPTIONS:**

1. Gravity (nonmotorized) dampers are not required to be tested to verify the air leakage rating when installed in exhaust systems where the exhaust capacity does not exceed 400 cfm and the gravity damper is provided with a gasketed seal.
2. Motorized dampers on return air openings in unitary packaged equipment that have the minimum leakage rate available from the manufacturer.

**C403.7.8.4 Damper actuation.** Outdoor air intake, relief and exhaust shutoff dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with the *International Mechanical Code* or the dampers are opened to provide intentional economizer cooling. Stairway and elevator hoistway shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

**C403.8 Fan and fan controls.** Fans in HVAC systems shall comply with Sections C403.8.1 through C403.8.5.1. The airflow requirements of Section C403.8.5.1 shall apply to all fan motors. Low capacity ventilation fans shall also comply with Section C403.8.4.

**C403.8.1 Fan System.** Each *fan system* that includes at least one fan or fan array with *fan electrical input power* ≥ 1 kW, moving air into, out of, or between conditioned spaces or circulating air for the purpose of conditioning air within a space shall comply with Sections C403.8.1.1 through C403.8.1.2.

**C403.8.1.1 Determining fan power budget.** For each *fan system*, the *fan system electrical input power* (Fan $kW_{design,system}$) determined in accordance with Section C403.8.1.2 at the *fan system airflow* shall not exceed Fan $kW_{budget}$. Calculate fan power budget (Fan $kW_{budget}$) for each fan system as follows:

1. Determine the *fan system airflow* and choose the appropriate table(s) for fan power allowance.
   1.1. For *single-cabinet fan systems*, use the *fan system airflow* and the power allowances in both Table C403.8.1.1(1) and Table C403.8.1.1(2).
   1.2. For *supply-only fan systems*, use the *fan system airflow* and power allowances in Table C403.8.1.1(1).
   1.3. For *relief fan systems*, use the design relief airflow and the power allowances in Table C403.8.1.1(2).
   1.4. For exhaust, return and transfer *fan systems*, use the *fan system airflow* and the power allowances in Table C403.8.1.1(2).
   1.5. For complex and DOAS with energy recovery *fan systems*, separately calculate the *fan power* allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1.1(1). For the return/exhaust airflow, use return/exhaust airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1.1(2).
2. For each *fan system*, determine the components included in the fan system and sum the fan power allowances of those components. All fan systems shall include the system base allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the fan power allowance for that component in accordance with Equation 4-11:

1. Use the default *Fan* $kW_{design}$ in Table C403.8.1.2 for one or more of the fans. This method cannot be used for *complex fan systems*.
2. Use the *Fan* $kW_{design}$ at *fan system design conditions* provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in 10 C.F.R. Part 430, 10 C.F.R. Part 431, ANSI/AMCA 208, ANSI/AMCA S210, AHRI 430, AHRI 440, or ISO 5801.
3. Use the *Fan* $kW_{design}$ provided by the manufacturer, calculated at *fan system design conditions* per one of the methods listed in Section 5.3 of ANSI/AMCA 208.
4. Determine the *Fan* $kW_{design}$ by using the maximum electrical input power provided on the motor nameplate.

**Table C403.8.1.2**
**Default Values for Fan $kW_{design}$ Based on Motor Nameplate HP[a,b]**

| Motor Nameplate HP | Default *Fan* $kW_{design}$ with variable speed drive (Fan $kW_{design}$) | Default *Fan* $kW_{design}$ without variable speed drive (Fan $kW_{design}$) |
|---|---|---|
| <1 | 0.96 | 0.89 |
| ≥1 and <1.5 | 1.38 | 1.29 |
| ≥1.5 and <2 | 1.84 | 1.72 |
| ≥2 and <3 | 2.73 | 2.57 |
| ≥3 and <5 | 4.38 | 4.17 |
| ≥5 and <7.5 | 6.43 | 6.15 |
| ≥7.5 and <10 | 8.46 | 8.13 |
| ≥10 and <15 | 12.4 | 12.0 |
| ≥15 and <20 | 16.5 | 16.0 |
| ≥20 and <25 | 20.5 | 19.9 |
| ≥25 and <30 | 24.5 | 23.7 |
| ≥30 and <40 | 32.7 | 31.7 |
| ≥40 and <50 | 40.7 | 39.4 |
| ≥50 and <60 | 48.5 | 47.1 |
| ≥60 and <75 | 60.4 | 58.8 |
| ≥75 and ≤100 | 80.4 | 78.1 |

**C403.8.2 Motor nameplate horsepower.** For each fan, the selected fan motor shall be no larger than the first available motor size greater than the brake horsepower (bhp). The fan brake horsepower (bhp) shall be indicated on the design documents to allow for compliance verification by the *code official*.

**EXCEPTIONS:**

1. For fans less than 6 bhp (4476 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 (4476 W) and larger, where the first available motor larger than the bhp has a nameplate rating within 30 percent of the bhp, selection of the next larger nameplate motor size is allowed.
3. For fans used only in *approved* life safety applications such as smoke evacuation.
4. Fans with motor nameplate horsepower less than 1 hp or fans with a fan motor nameplate electrical input power of less than 0.89 kW.
5. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.

**C403.8.3 Fan efficiency.** Each fan and *fan array* shall have a *fan energy index (FEI)* of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an *approved*, independent testing laboratory and labeled by the manufacturer. Each fan and *fan array* used for a variable-air volume system shall have an *FEI* of not less than 0.95 at the design point of operation as determined in accordance with AMCA 208 by an *approved*, independent testing laboratory and labeled by the manufacturer. The *FEI* for *fan arrays* shall be calculated in accordance with AMCA 208 Annex C.

**EXCEPTION:** The following fans are not required to have a fan energy index:

1. Fans that are not *embedded* ((~~*pans*~~)) fans with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.
2. *Embedded fans* that have a motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.

3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.
4. Fans that are part of equipment covered under Section C403.3.2.
5. Fans included in an equipment package certified by an *approved agency* for air or energy performance.
6. *Ceiling fans*.
7. Fans used for moving gases at temperatures above 425°F (250°C).
8. Fans used for operation in explosive atmospheres.
9. Reversible fans used for tunnel ventilation.
10. Fans that are intended to operate only during emergency conditions.
11. Fans outside the scope of AMCA 208.

**C403.8.4 Low-capacity ventilation fans.** Mechanical ventilation system fans with motors less than 1/12 hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.4 ((~~at one or more rating points~~)). Airflow shall be tested in accordance with the test procedure referenced in Table C403.8.4 and listed. The efficacy, airflow divided by power, shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. The efficacy shall be determined using the input power at a listed airflow that is not less than the design airflow or shall be determined by interpolating between the input power at the two nearest listed airflow rates. Design airflow, power, and efficacy shall be reported on the mechanical equipment schedule submitted in the permit documents.

**EXCEPTIONS:**

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators and domestic range booster fans that operate intermittently.
3. Fans in radon mitigation systems.
4. Fans not covered within the scope of the test methods referenced in Table C403.8.5.
5. Ceiling fans regulated under 10 CFR 430 Appendix U.
6. Mechanical ventilation system types with an input power greater than 62 watts having electronically commutated motors or motors with a minimum efficiency of 70 percent when rated in accordance with DOE 10 CFR 431. Such systems shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustment for airflow balancing in lieu of a varying motor speed. The efficiency shall be verified through certification under an approved certification program, or, where no certification program exists, the equipment efficiency rating shall be supported by data furnished by the motor manufacturer.

The efficacy shall be determined at a listed airflow that is not less than the design airflow or shall be determined by interpolating between the efficacies determined at the two nearest listed airflow rates.

((~~**Table C403.8.4**~~
~~**Low-Capacity Ventilation Fan Efficacy**~~[a]

| ~~Fan Location~~ | ~~Airflow Rate Minimum (cfm)~~ | ~~Minimum Efficacy (cfm/watt)~~ | ~~Airflow Rate Maximum (cfm)~~ |
|---|---|---|---|
| ~~HRV or ERV~~ | ~~Any~~ | ~~1.2 cfm/watt~~ | ~~Any~~ |
| ~~Range hood~~ | ~~Any~~ | ~~2.8 cfm/watt~~ | ~~Any~~ |
| ~~In-line fan~~ | ~~Any~~ | ~~3.8 cfm/watt~~ | ~~Any~~ |
| ~~Bathroom, utility room~~ | ~~10~~ | ~~2.8 cfm/watt~~ | ~~< 90~~ |
| ~~Bathroom, utility room~~ | ~~90~~ | ~~3.5 cfm/watt~~ | ~~Any~~ |

~~For SI: 1 cfm/ft = 47.82 W.~~

~~a. Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.~~))

**Table C403.8.4**
**Low-Capacity Ventilation Fan Efficacy[a]**

| System Type | Airflow Rate (cfm) | Minimum Efficacy (cfm/watt) | Minimum Static Pressure for Testing | Test Procedure |
|---|---|---|---|---|
| Balanced ventilation system without heat or energy recovery | Any | 1.2[a] | 0.2 inch w.c. | ASHRAE Standard 51 (ANSI/AMCA Standard 210) |
| HRV or ERV | Any | 1.2[a] | 0.2 inch w.c.[b] | CAN/CSA 439-18 |
| Range hood | Any | 2.8 | 0.1 inch w.c. | ASHRAE 51 (ANSI/AMCA Standard 210) |
| In-line supply or exhaust fan | Any | 3.8 | 0.2 inch w.c. | |
| Other exhaust fan | ≤90 | 2.8 | 0.1 inch w.c. | |
| | >90 and <200 | 3.5 | 0.1 inch w.c. | |
| | ≥200 | 4.0 | 0.1 inch w.c. | |

For SI: 1 cfm/ft = 47.82 W.

a. For balanced systems, HRVs, and ERVs, the efficacy shall be determined as the outdoor airflow divided by the total fan power of the system.

b. The minimum static pressure for determining HRV or ERV fan efficacy shall be 0.4 inch w.c. for airflows greater than or equal to 100 L/s.

**C403.8.5 Fan controls.** Controls shall be provided for fans in accordance with Section C403.8.5.1 and as required for specific systems provided in Section C403.

**C403.8.5.1 Fan airflow control.** Each cooling system listed in Table C403.8.5.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:

1. Direct expansion (DX) and chilled water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the fan system shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
2. Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed, the fan system shall draw no more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.
3. Units that include an airside economizer in accordance with Section C403.5 shall have not fewer than two speeds of fan control during economizer operation.

**EXCEPTIONS:**

1. Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide ventilation air and the indoor fan cycles with the load.
2. Where the volume of outdoor air required to comply with the ventilation requirements of the *International Mechanical Code* at low speed exceeds the air that would be delivered at the minimum speed defined in Section C403.8.5, the minimum speed shall be selected to provide the required ventilation air.

**Table C403.8.5.1**
**Fan Control**

| Cooling System Type | Fan Motor Size | Mechanical Cooling Capacity |
|---|---|---|
| DX cooling | Any | ≥ 42,000 Btu/h |
| Chilled water and evaporative cooling | ≥ 1/4 hp | Any |

**C403.8.6 Large-diameter ceiling fans.** Where provided, *large-diameter ceiling fans* shall be tested and labeled in accordance with AMCA 230.

**C403.9 Heat rejection and heat recovery equipment.**

**C403.9.1 Heat rejection equipment.** Heat rejection equipment, including air-cooled condensers, dry coolers, open-circuit cooling towers, closed-circuit cooling towers and evaporative condensers, shall comply with this section.

**EXCEPTION:** Heat rejection devices where energy usage is included in the equipment efficiency ratings listed in Tables C403.3.2(1), C403.3.2(2), C403.3.2(3), C403.3.2(4), C403.3.2(8), C403.3.2(9), C403.3.2(10) and C403.3.2(16).

Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table C403.3.2(7).

**C403.9.1.1 Fan speed control.** Each fan powered by an individual motor or array of motors with a connected power, including the motor and devices configured to automatically modulate the fan speed to control the leaving fluid temperature or condensing temperature and pressure of the heat rejection device. Fan motor power input shall be not more than 30 percent of design wattage at 50 percent of the design airflow.

**EXCEPTIONS:**

1. Fans serving multiple refrigerant or fluid cooling circuits.
2. Condenser fans serving flooded condensers.

**C403.9.1.2 Multiple-cell heat rejection equipment.** Multiple-cell heat rejection equipment with variable speed fan drives shall be controlled to operate the maximum number of fans allowed that comply with the manufacturer's requirements for all system components and so that all fans can operate at the same fan speed required for the instantaneous cooling duty, as opposed to staged (on/off) operation. The minimum fan speed shall be the minimum allowable speed of the fan drive system in accordance with the manufacturer's recommendations.

**C403.9.1.3 Limitation on centrifugal fan open-circuit cooling towers.** Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1,100 gpm (4164 L/m) or greater at 95°F (35°C) condenser water return, 85°F (29°C) condenser water supply, and 75°F (24°C) outdoor air wet-bulb temperature shall meet the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table C403.3.2(7).

**C403.9.1.4 Tower flow turndown.** Open-circuit cooling towers used on water-cooled chiller systems that are configured with multiple- or variable-speed condenser water pumps shall be designed so that all open circuit cooling tower cells can be run in parallel with the larger of the flow that is produced by the smallest pump at its minimum expected flow rate or at 50 percent of the design flow for the cell.

**C403.9.2 Heat recovery.**

**C403.9.2.1 Condenser 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 recovered energy.

**C403.9.2.2 Steam condensate systems.** On-site steam heating systems shall have condensate water ((~~heat~~)) recovery. On-site includes a system that is located within or adjacent to one or more buildings within the boundary of a contiguous area or campus under one ownership and which serves one or more of those buildings.

Buildings using off-site generated steam where the condensate is not returned to the source, shall have an on-site condensate water heat recovery system.

**C403.9.2.3 Refrigeration condenser heat recovery.** Facilities having food service, meat or deli departments and having 500,000 Btu/h or greater of remote refrigeration condensers shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, space heating or for dehumidification reheat. Facilities having a gross conditioned floor area of 40,000 $ft^2$ 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.

**C403.9.2.4 Condenser heat recovery for space heating.** A water-source condenser heat recovery system meeting the requirements of Sections C403.9.2.4.1 through C403.9.2.4.4 shall be installed to serve space and ventilation heating systems in new buildings and additions meeting the following criteria:

1. The facility operates greater than 70 hours per week.
2. The sum of all heat rejection equipment capacity serving the new building or addition exceeds 1,500,000 Btu/hr.
3. The sum of zone minimum airflows in all zones with zone reheat coils divided by the conditioned floor area served by those systems is at least 0.45 cfm per square foot.

**EXCEPTION:** Systems complying with Section C403.3.5, Dedicated outdoor air systems.

**C403.10.1.2 Other supply and return ducts.** All other supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in unconditioned spaces, and where located outside the building with a minimum of R-8 insulation in Climate Zone 4 and R-12 insulation in Climate Zone 5. Ducts located underground beneath buildings shall be insulated as required in this section or have an equivalent *thermal distribution efficiency*. Underground ducts utilizing the *thermal distribution efficiency* method shall be listed and labeled to indicate the *R*-value equivalency. Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by minimum insulation value as required for exterior walls by Section C402.1.3.

**EXCEPTIONS:**

1. Where located within equipment.
2. Supply and return ductwork located in unconditioned spaces where the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F (8°C) and are insulated in accordance with Table C403.10.1.2.

Where located within conditioned space, supply ducts which convey supply air at temperatures less than 55°F or greater than 105°F shall be insulated with a minimum insulation *R*-value in accordance with Table C403.10.1.2.

**EXCEPTION:** Ductwork exposed to view within a zone that serves that zone is not required to be insulated.

Where located within conditioned space, return or exhaust air ducts that convey return or exhaust air downstream of an energy recovery media shall be insulated with a minimum insulation *R*-value in accordance with Table C403.10.1.2.

Where located within conditioned space, ducts that convey air from outside the conditioned space shall be insulated with a minimum insulation R-value in accordance with Table C403.10.1.2.

Where located within conditioned space, ducts that convey ambient air to and from outside for the condenser section of HVAC heat pumps, service hot water heat pumps, or air conditioning units shall be insulated with a minimum insulation R-value in accordance with Table C403.10.1.2.

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

**Table C403.10.1.2**
**Supply, Return, Exhaust and Relief Air Ductwork Insulation**

| Duct System | Duct Location and Use | Climate Zone | Minimum Installed Duct Insulation *R*-value[a,b] | Notes |
|---|---|---|---|---|
| Supply air or return air | Outside the building (outdoors and exposed to weather)[c] | 4C | R-8 | See Section C403.10.1.2 for details |
| Supply air or return air | Outside the building (outdoors and exposed to weather)[c] | 5B | R-12 | See Section C403.10.1.2 for details |
| Supply air or return air | Unconditioned space (enclosed but not in the building conditioned envelope) | 4C and 5B | R-6 | See Section C403.10.1.2 for details |
| Supply air or return air | Unconditioned space where the duct conveys air that is within 15°F of the air temperature of the surrounding unconditioned space | 4C and 5B | R-3.3 | See IMC Section 603.12 for additional requirements for condensation control at ductwork |
| Supply air or return air | Where located in a building envelope assembly | 4C and 5B | R-16 | Duct or plenum is separated from building envelope assembly with the minimum insulation value |
| Supply air | Within conditioned space where the supply duct conveys air that is less than 55°F or greater than 105°F | 4C and 5B | R-3.3 | See Section C403.10.1.2 for details |
| Supply air | Within conditioned space that the duct directly serves where the supply duct conveys air that is less than 55°F or greater than 105°F | 4C and 5B | None | See Section C403.10.1.2 for details |
| Supply air | Within conditioned space where the supply duct conveys air that is 55°F or greater and 105°F or less | 4C and 5B | None | |
| Return or exhaust air | Within conditioned space, downstream of an energy recovery media, upstream of an automatic shutoff damper | 4C | R-8 | |

**Table C403.10.1.2—continued**
**Supply, Return, Exhaust and Relief Air Ductwork Insulation**

| Duct System | Duct Location and Use | Climate Zone | Minimum Installed Duct Insulation *R*-value[a,b] | Notes |
|---|---|---|---|---|
| Return or exhaust air | Within conditioned space, downstream of an energy recovery media, upstream of an automatic shutoff damper | 5B | R-12 | |
| Relief or exhaust air | Conditioned space and downstream of an automatic shutoff damper | 4C and 5B | R-16 | |
| Exhaust or other air duct | Duct conveying air from unconditioned space through conditioned space | 4C and 5B | R-16 | |
| Condenser air intake and outlet | Conditioned space and conveys ambient air to or from the outdoors to heat pump or AC unit condenser | 4C and 5B | ≤ 2800 CFM = R-8<br>≥ 2800 CFM = R-16 | |

a Insulation R-values, measured in h•ft²•°F/Btu, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a mean temperature of 75°F at the installed thickness.

b See *International Mechanical Code* Sections 603.12 and 604 for further details on duct insulation requirements.

c Includes attics above insulated ceilings, parking garages and crawl spaces.

**C403.10.2 Duct construction.** Ductwork shall be constructed and erected in accordance with the *International Mechanical Code*. 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. Ducts shall be leak-tested where required by Section C403.10.2.4.

**C403.10.2.1 Low-pressure duct systems.** Longitudinal and transverse joints, seams and connections of supply and return ducts operating at a static pressure less than or equal to 2 inches water gauge (w.g.) (500 Pa) shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus embedded-fabric systems or tapes 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.

**C403.10.2.2 Medium-pressure duct systems.** Ducts and plenums designed to operate at a static pressure greater than 2 inches water gauge (w.g.) (500 Pa) but less than 3 inches w.g. (750 Pa) shall be insulated and sealed in accordance with Section C403.10.1. Pressure classifications specific to the duct system shall be clearly indicated on the construction documents in accordance with the *International Mechanical Code*.

**C403.10.2.3 High-pressure duct systems.** Ducts designed to operate at static pressures equal to or greater than 3 inches water gauge (w.g.) (750 Pa) shall be insulated and sealed in accordance with Section C403.10.1.

**C403.10.2.4 Duct leak testing.** ((~~In addition, ducts~~)) Ducts and plenums designed to operate at static pressures equal to or greater than 3 inches water gauge (w.g.) (750 Pa) and all supply and return ductwork that is located outside the *building thermal envelope* and that serves *conditioned space*, regardless of the Design Construction Pressure Class level, shall be leak-tested in accordance with the SMACNA *HVAC Air Duct Leakage Test Manual* and shown to have a rate of air leakage (*CL*) less than or equal to 4.0, as determined in accordance with Equation 4-12. Ducts shall be tested using a pressure equal to the average operating pressure or the design Duct Construction Pressure Class level in accordance with the SMACNA HVAC Air Duct Leakage Test Manual.

$$CL = F/P^{0.65} \qquad \textbf{(Equation 4-12)}$$

Where:

$F$ = The measured leakage rate in cfm per 100 square feet of duct surface.

$P$ = The static pressure of the test.

Documentation shall be furnished demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

**C403.10.3 Piping insulation.** All piping, other than field installed HVAC system refrigerant piping, serving as part of a heating or cooling system shall be thermally insulated in accordance with Table C403.10.3.

**C403.11 Mechanical systems located outside of the building thermal envelope.** Mechanical systems providing heat outside of the thermal envelope of a building shall be configured to comply with Section C403.11.1 through C403.11.3, and shall be provided with an electric heat pump or electric resistance heating system in accordance with Section C403.1.4.

**C403.11.1 Heating outside a building or in unheated spaces.** Systems installed to provide heat outside a building or in unheated spaces 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 in the area heated by each individual device for a period not to exceed 20 minutes.

**C403.11.2 Snow- and ice-melt system controls.** Snow- and ice-melting systems, supplied through energy service to the building, shall include *automatic* controls configured to shut off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling and an *automatic* control that is configured to shut off when the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible.

**C403.11.3 Freeze protection system controls.** Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include *automatic* controls configured to shut off the systems when outdoor air temperatures are above 40°F (4°C) or when the conditions of the protected fluid will prevent freezing.

**C403.12 High efficiency single-zone variable air volume (VAV) systems.**

1. The single-zone VAV system is provided with airside economizer in accordance with Section C403.3 without exceptions.
2. A direct-digital control (DDC) system is provided to control the system as a single zone in accordance with Section C403.4.11 regardless of sizing thresholds of Table C403.4.11.1.
3. Single-zone VAV systems with a minimum outdoor air requirement of 1,000 cfm (472 L/s) or greater shall be equipped with a device capable of measuring outdoor airflow intake under all load conditions. The system shall be capable of increasing or reducing the outdoor airflow intake based on Section C403.7.1, Demand controlled ventilation.
4. Allowable fan power shall not exceed 90 percent of the allowable fan power budget as defined by Section C403.8.1.1.
5. Each single-zone VAV system shall be designed to vary the supply fan airflow as a function of heating and cooling load and minimum fan speed shall not be more than the greater of:
   5.1. 30 percent of peak design airflow; or
   5.2. The required ventilation flow assuming no occupants.
6. Spaces that are larger than 150 square feet (14 $m^2$) and with an occupant load greater than or equal to 25 people per 1000 square feet (93 $m^2$) of floor area (as established in Table 403.3.1.1 of the *International Mechanical Code*) shall be provided with all of the following features:
   6.1. Demand control ventilation (DCV) shall be provided that utilizes a carbon dioxide sensor to reset the ventilation setpoint of the single-zone VAV system from the design minimum to design maximum ventilation rate as required by Chapter 4 of the *International Mechanical Code*.
   6.2. Occupancy sensors shall be provided that are configured to reduce the minimum ventilation rate to zero and setback room temperature setpoints by a minimum of 5°F, for both cooling and heating, when the space is unoccupied.
7. Single-zone VAV systems shall comply with one of the following options:
   7.1. Single-zone VAV air handling units with a hydronic heating coil connected to systems with hot water generation equipment limited to the following types of equipment: ((~~Gas-fired hydronic boilers with a thermal efficiency, $E_t$, of not less than 92 percent,~~)) air-to-water heat pumps or heat recovery chillers. Hydronic heating coils shall be sized for a maximum entering hot water temperature of 120°F for peak anticipated heating load conditions.
   7.2. Single-zone VAV air handing units with a chilled water coil connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than the minimum part load efficiencies listed in Table C403.3.2(3), in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify. The smallest chiller or compressor in the central plant shall not exceed 20 percent of the total central plant cooling capacity or the chilled water system shall include thermal storage sized for a minimum of 20 percent of the total central cooling plant capacity.
   7.3. Single-zone VAV air handling units with DX cooling, heat pump heating or gas-fired furnace shall comply with the following requirements as applicable:
      7.3.1. Have a DX cooling coil with cooling part load efficiency that is a minimum of 15 percent higher than the minimum SEER or IEER listed in Tables C403.3.2(1), C403.3.2(2), and C403.3.2 (14).

7.3.2. Have a gas-fired furnace with a thermal efficiency, $E_t$, of not less than 90 percent or heat pump with a minimum heating HSPF or COP efficiency that are a minimum of 10 percent higher than the minimum heating efficiency in Tables C403.3.2(1), C403.3.2(2), and C403.3.2(14).

7.3.3. Heating coils or burner output shall be modulating or have a minimum of 2 stages with the first stage being less than 50 percent of total heating capacity. Cooling coils shall be modulating or have a minimum of 2 stages with the first stage being less than 50 percent of the total cooling capacity.

8. The DDC system shall include a fault detection and diagnostics (FDD) system complying with the following:

8.1. The following temperature sensors shall be permanently installed to monitor system operation:

8.1.1. Outside air.

8.1.2. Supply air.

8.1.3. Return air.

8.2. Temperature sensors shall have an accuracy of ±2°F (1.1°C) over the range of 40°F to 80°F (4°C to 26.7°C).

8.3. The single-zone VAV air handling unit controller shall be configured to provide system status by indicating the following:

8.3.1. Free cooling available.

8.3.2. Economizer enabled.

8.3.3. Compressor enabled.

8.3.4. Heating enabled.

8.3.5. Mixed air low limit cycle active.

8.3.6. The current value of each sensor.

8.4. The single-zone VAV air handling unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.

8.5. The single-zone VAV air handling unit shall be configured to report faults to a fault management application able to be accessed by day-to-day operating or service personnel or annunciated locally on zone thermostats.

8.6. The FDD system shall be configured to detect the following faults:

8.6.1. Air temperature sensor failure/fault.

8.6.2. Not economizing when the unit should be economizing.

8.6.3. Economizing when the unit should not be economizing.

8.6.4. Outdoor air or return air damper not modulating.

8.6.5. Excess outdoor air.

**C403.13 Dehumidification in spaces for plant growth and maintenance.** Equipment that dehumidifies building spaces used for plant growth and maintenance shall be one of the following:

1. *Stand-alone dehumidifiers* that meet the following minimum integrated energy factors as measured by the test conditions in Appendix X1 to Subpart B of 10 C.F.R. Part 430:

1.1. Minimum integrated energy factor of 1.77 L/kWh for product case volumes of 8.0 cubic feet or less;

1.2. Minimum integrated energy factor of 2.41 L/kWh for product case volumes greater than 8.0 cubic feet;

2. *Integrated HVAC system* including, but not limited to, heat pump technology, with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat;

3. Chilled water system including, but not limited to, heat pump technology, with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat; or

4. Solid or liquid *desiccant dehumidification system* for system designs that require dewpoint of 50°F (10°C) or less.

**C403.14 Commissioning.** Mechanical systems shall be commissioned in accordance with Section C408.

## SECTION C404
## SERVICE WATER HEATING AND PRESSURE-BOOSTER SYSTEMS

**C404.1 General.** This section covers the minimum efficiency of, and controls for, service water-heating equipment and insulation of service hot water piping.

**EXCEPTION:** Energy using equipment used by a manufacturing, industrial or commercial process other than maintaining comfort and amenities for the occupants are exempt from all Section C404 subsections except Sections C404.2, C404.6 and C404.13. Laboratory sinks are considered to be process equipment for the purposes of this exception.

**C404.2 Service water-heating equipment performance efficiency.** Water-heating equipment and hot water storage tanks shall meet the requirements of Table C404.2. The efficiency shall be verified through certification and *listed* under an *approved* certification program, or if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Water-heating equipment intended to be used to provide space heating shall meet the applicable provisions of Table C404.2.

**C404.2.1 Service water heating system type.** Service hot water shall be provided by an electric air-source heat pump water heating (HPWH) system, or a ground-source heat pump water heating (GSHP) system. meeting the requirements of this section. Supplemental service water heating equipment is permitted to use electric resistance ((~~or fossil fuel~~)) in compliance with Section C404.2.1.4.

**EXCEPTIONS:**

1. 24 kW plus 0.1 watts per square foot of building area of electric resistance service water heating capacity is allowed per building.
2. Solar thermal, wastewater heat recovery, other *approved* waste heat recovery, ((~~ground-source heat pumps,~~)) water-source heat pump systems utilizing waste heat, and combinations thereof, are permitted to offset all or any portion of the required HPWH capacity where such systems comply with this code and the *Uniform Plumbing Code*, and are not claimed in Section C406.2.5, C407, or C411.
3. Systems that comply with the Northwest Energy Efficiency Alliance (NEEA) Commercial Electric Advanced Water Heating Specification.

**SDCI Informative Note:** To view the NEEA Advanced Water Heating Specification (AWHS) for central service water heating systems, see AWHS v8.0 (http://www.neea.org).

4. Service hot water systems served by a district energy system that serves multiple buildings and that was in service before the effective date of this code, including more energy-efficient upgrades to such existing systems, are permitted to serve as the primary heating energy source.
5. Commercial dishwashers, commercial food service equipment, and other *approved* process equipment are permitted to utilize electric booster heaters for supply water temperatures 120°F (49°C) or higher.
6. Systems connected to a *low-carbon district energy exchange system* or a *low-carbon district heating and cooling or heating only system*.
7. Essential facilities. Groups I-2 and I-3 occupancies that by regulation are required to have in place redundant emergency backup systems are permitted to use electric resistance or fossil fuel combustion equipment for those emergency backup systems.
8. Point of use instantaneous electric water heaters, serving fixtures no more than 8 feet of developed pipe length from the water heater, are permitted and do not contribute to the building combined water heating capacity calculation.
9. For other than Group R and Group I occupancies, unitary electric air-source heat pump water heaters are permitted to extract heat from the conditioned space where the primary source of space heating is electric heat pump or where heat recovery of waste heat is available, and where they are sized to meet all calculated service water heating demand using the heat pump compressor, and not supplementary heat.

**SDCI Informative Note:** For the purposes of this exception, "heat recovery of waste heat" can utilize heat from commercial cooking appliances, freezers, refrigerators, electronic equipment, machine rooms, and other internal heat sources. Such heat production must have sufficient magnitude and consistency to provide the majority of the heat energy required by operation of the heat pump water heater.

10. Standby service water heating equipment provided in addition to the primary heating system, and controlled such that it will only be used when the primary heating equipment is not available, is permitted to be electric resistance.

**C404.2.1.1 Primary heat pump system sizing.** The primary heat pump service water heating system shall be sized to deliver no less than ((~~50~~)) 100 percent of the calculated demand for service hot water production during the peak demand period. Demand shall be calculated using the equipment manufacturer's selection criteria or another *approved* methodology with entering dry bulb or wet bulb outdoor air temperature at 40°F (4°C) for air source heat pumps or 44°F (7°C) ground temperature for ground-source heat pumps. Electric air source heat pumps shall also be sized to deliver no

less than ((~~25~~)) 50 percent of the calculated demand for service hot water production during the peak demand period when entering dry bulb or wet bulb outdoor air temperature is 24°F (-4°C). The remaining primary service output may be met by ((~~fossil fuel,~~)) electric resistance, or heat pump water heating systems.

**EXCEPTIONS:**

1. ((~~Twenty five~~)) Fifty percent sizing at entering dry bulb or wet bulb air temperature of 24°F (-4°C) is not required for air-source heat pumps located in a below-grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F (4°C) at any time.
2. Any of the following system types are permitted to replace all or part of the primary heat pump service water heating system capacity:
    a. Wastewater heat recovery systems that recover heat from wastewater of both cold and hot water plumbing fixtures and that utilize electric water-source heat pumps. The heat pumps shall be sized for incoming wastewater temperatures of no higher than 70°F (21°C) for Group R and Group I occupancies, and no higher than 60°F (16°C) for all other occupancies, unless an alternate wastewater temperature is *approved* by the code official.
    b. Solar thermal systems.
    c. Other electric water-source heat pump systems that utilize waste heat recovered from year-round mechanical cooling loads or other *approved* sources.

**C404.2.1.2 Primary hot water storage sizing.** The system shall provide sufficient hot water, as calculated using an *approved* methodology, to satisfy peak demand period requirements.

**C404.2.1.3 System design.** The service water heating system shall be configured to conform to one of the following provisions:

1. For *single-pass heat pump water heaters*, *temperature maintenance* heating provided for reheating return water from the building's heated water circulation system shall be physically decoupled from the primary service water heating system storage tank(s) in a manner that prevents destratification of the primary system storage tanks. *Temperature maintenance* heating is permitted to be provided by electric resistance, fossil fuel, or a separate dedicated heat pump system.
2. For *multi-pass heat pump water heaters*, *recirculated temperature* maintenance water is permitted to be returned to the primary water storage tanks for reheating.
3. ((~~For unitary~~)) Unitary heat pump water heaters, located in conditioned space, are permitted, where they are sized to meet all calculated service water heating demand using the heat pump compressor, and not supplementary heat.

**C404.2.1.3.1 Mixing valve.** A thermostatic or electronic mixing valve capable of supplying hot water to the building at the user temperature setpoint shall be provided, in compliance with requirements of the ((~~*Uniform*~~)) Seattle *Plumbing Code* and the HPWH manufacturer's installation guidelines. The mixing valve shall be sized and rated to deliver tempered water in a range from the minimum flow of the *temperature maintenance* recirculation system up to the maximum demand for the fixtures served.

**C404.2.1.4 Supplemental water heating.** Total supplemental water heating equipment shall not have an output capacity greater than the total summed capacity of all primary water heating equipment. For the purposes of determining this supplemental water heating allowance, the capacity of primary water heating equipment shall be evaluated at 40°F (4°C) entering dry bulb or wet bulb outdoor air temperature for air-source heat pumps, 44°F (7°C) ground temperature for ground-source heat pumps, and at the nameplate input rate for all other water heater system types. Supplemental heating is permitted for the following uses:

1. Temperature maintenance of heated-water circulation systems, physically separate from the primary service water heating system.
2. Defrost of compressor coils.
3. Heat tracing of piping for freeze protection or for temperature maintenance in lieu of recirculation of hot water.
4. Backup or low ambient temperature conditions, where all of the following are true:
    4.1. During normal operations, the supplemental heating is controlled to operate only when the entering air temperature at the air-source HPWH is below 40°F (4°C), and the primary HPWH compressor continues to operate together with the supplemental heating.
    4.2. The primary water heating equipment cannot satisfy the system load due to equipment failure or entering air temperature below 40°F (4°C).

**C404.2.1.5 System fault detection.** The control system shall be capable of and configured to send automatic error alarms to building or maintenance personnel upon detection of equipment faults, low leaving water temperature from primary storage tanks, or low hot water supply delivery temperature to building distribution system.

**Table C404.2**
**Minimum Performance of Water-Heating Equipment**

| Equipment Type | Size Category (input) | Subcategory or Rating Condition | Draw Pattern | Performance Required[a,j] | Test Procedure[b] |
|---|---|---|---|---|---|
| Electric table-top water heaters[k] | ≤ 12 kW[c] | ≥ 20 gal<br>≤ 120 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.6323 - (0.0058 × Vr)<br>UEF ≥ 0.9188 - (0.0031 × Vr)<br>UEF ≥ 0.9577 - (0.0023 × Vr)<br>UEF ≥ 0.9884 - (0.0016 × Vr) | DOE 10 C.F.R. Part 430 App. E |
| Electric storage water heaters[g,i] resistance and heat pump | ≤ 12 kW[c] | ≥ 20 gal<br>≤ 55 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.8808 - (0.0008 × Vr)<br>UEF ≥ 0.9254 - (0.0003 × Vr)<br>UEF ≥ 0.9307 - (0.0002 × Vr)<br>UEF ≥ 0.9349 - (0.0001 × Vr) | DOE 10 C.F.R. Part 430 App. E |
| | ≤ 12 kW | > 55 gal<br>≤ 120 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 1.9236 - (0.0011 × Vr)<br>UEF ≥ 2.0440 - (0.0011 × Vr)<br>UEF ≥ 2.1171 - (0.0011 × Vr)<br>UEF ≥ 2.2418 - (0.0011 × Vr) | DOE 10 C.F.R. Part 430 App. E |
| Electric storage water heaters[g] | > 12 kW | | | (0.3 + 27/Vm), %h | DOE 10 C.F.R. 431.106 App B. |
| Grid-enabled water heaters[g,l] | | > 75 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 1.0136 - (0.0028 × Vr)<br>UEF ≥ 0.9984 - (0.0014 × Vr)<br>UEF ≥ 0.9853 - (0.0010 × Vr)<br>UEF ≥ 0.9720 - (0.0007 × Vr) | 10 C.F.R. 430 Appendix E |
| Electric instantaneous water heater[h] | ≤ 12 kW | < 2 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.91<br>UEF ≥ 0.91<br>UEF ≥ 0.91<br>UEF ≥ 0.92 | DOE 10 C.F.R. Part 430 |
| | > 12 kW &<br>≤ 58.6 kW[c] | ≤ 2 gal<br>≤ 180°F | All | UEF ≥ 0.80 | DOE 10 C.F.R. Part 430 |
| Gas storage water heaters[g] | ≤ 75,000 Btu/h | ≥ 20 gal &<br>≤ 55 gal[f] | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.3456 - (0.0020 × Vr)<br>UEF ≥ 0.5982 - (0.0019 × Vr)<br>UEF ≥ 0.6483 - (0.0017 × Vr)<br>UEF ≥ 0.6920 - (0.0013 × Vr) | DOE 10 C.F.R. Part 430 App. E |
| | ≤ 75,000 Btu/h | > 55 gal &<br>≤ 100 gal[f] | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.6470 - (0.0006 × Vr)<br>UEF ≥ 0.7689 - (0.0005 × Vr)<br>UEF ≥ 0.7897 - (0.0004 × Vr)<br>UEF ≥ 0.8072 - (0.0003 × Vr) | DOE 10 C.F.R. Part 430 App. E |
| | > 75,000 Btu/h and<br>≤ 105,000 Btu/h[d] | ≤ 120 gal<br>≤ 180°F | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.2674-0.0009 x Vr<br>UEF ≥ 0.5362-0.0012 x Vr<br>UEF ≥ 0.6002-0.0011 x Vr<br>UEF ≥ 0.6597-0.0009 x Vr | DOE 10 C.F.R. Part 430 App. E |
| | > 105,000 Btu/h[d,f] | | | 80% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | DOE 10 C.F.R. 431.106 |
| Gas instantaneous water heater[h] | > 50,000 Btu/h and<br>< 200,000 Btu/h | < 2 gal | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.80<br>UEF ≥ 0.81<br>UEF ≥ 0.81<br>UEF ≥ 0.81 | DOE 10 C.F.R. Part 430 App. E |
| | ≥ 200,000 Btu/h[d,f] | < 10 gal | | 80% $E_t$ | DOE 10 C.F.R. 431.106 |
| | ≥ 200,000 Btu/h[f] | ≥ 10 gal | | 80% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | |

**Table C404.2—continued**
**Minimum Performance of Water-Heating Equipment**

| Equipment Type | Size Category (input) | Subcategory or Rating Condition | Draw Pattern | Performance Required[a,j] | Test Procedure[b] |
|---|---|---|---|---|---|
| Oil storage water heaters[g] | ≤ 105,000 Btu/h | ≤ 50 gal | Very small<br>Low<br>Medium<br>High | UEF = 0.2509 - (0.0012 × Vr)<br>UEF = 0.5330 - (0.0016 × Vr)<br>UEF = 0.6078 - (0.0016 × Vr)<br>UEF = 0.6815 - (0.0014 × Vr) | DOE 10 C.F.R. Part 430 |
| | > 105,000 Btu/h and ≤ 140,000 Btu/h[e] | ≤ 120 gal<br>≤ 180°F | Very small<br>Low<br>Medium<br>High | UEF ≥ 0.2932-0.0015 x Vr<br>UEF ≥ 0.5596-0.0018 x Vr<br>UEF ≥ 0.6194-0.0016 x Vr<br>UEF ≥ 0.6740-0.0013 x Vr | DOE 10 C.F.R. Part 430 App. E |
| | > 140,000 Btu/h | | | 80% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | DOE 10 C.F.R. 431.106 |
| Oil instantaneous water heater[h] | ≤ 210,000 Btu/h | < 2 gal | | 80% $E_t$<br>EF ≥ 0.59 - 0.0005 x V | DOE 10 C.F.R. Part 430 App. E |
| | > 210,000 Btu/h | < 10 gal | | 80% $E_t$ | DOE 10 C.F.R. 431.106 |
| | > 210,000 Btu/h | ≥ 10 gal | | 78% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | DOE 10 C.F.R. 431.106 |
| Hot water supply boilers, gas and oil[h] | ≥ 300,000 Btu/h and < 12,500,000 Btu/h | < 10 gal | | 80% $E_t$ | DOE 10 C.F.R. 431.106 |
| Hot water supply boilers, gas[h] | ≥ 300,000 Btu/h and < 12,500,000 Btu/h | ≥ 10 gal | | 80% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | DOE 10 C.F.R. 431.106 |
| Hot water supply boilers, oil[h] | ≥ 300,000 Btu/h and < 12,500,000 Btu/h | ≥ 10 gal | | 78% $E_t$<br>SL ≤ (Q/800 +110√V), Btu/h | DOE 10 C.F.R. 431.106 |
| Pool heaters, gas | All | | | 82% $E_t$ | DOE 10 C.F.R. Part 430 App. P |
| Heat pump pool heaters | All | 50°F db 44.2°F wb outdoor air 80.0°F entering water | | 4.0 COP | DOE 10 C.F.R. Part 430 App. P |
| Unfired storage tanks[m] | All | | | Minimum insulation requirement<br>R-12.5 (h-ft$^2$-°F)/Btu | (none) |

a Thermal efficiency ($E_t$) is a minimum requirement, while standby loss is a maximum requirement. In the standby loss equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h. $V_m$ is the measured volume in the tank in gallons. Standby loss for electric water heaters is in terms of %/h and denoted by the term "S," and standby loss for gas and oil water heaters is in terms of Btu/h and denoted by the term "SL" Draw pattern (DP) refers to the water draw profile in the Uniform Energy Factor (UEF) test. UEF and Energy Factor (EF) are minimum requirements. In the UEF standard equations, $V_r$ refers to the rated volume in gallons.

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

c Electric instantaneous water heaters with input capacity ≤ 12 kW and ≤ 58.6 kW that have either (1) a storage volume ≤ 2 gal; or (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power has no efficiency standard.

d Gas storage water heaters with input capacity ≤ 75,000 Btu/h and ≤ 105,000 Btu/h must comply with the requirements for the ≤ 105,000 Btu/h if the water heater either (1) has a storage volume ≤ 120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.

e Oil storage water heaters with input capacity ≤ 105,000 Btu/h and ≤ 140,000 Btu/h must comply with the requirements for the ≤ 140,000 Btu/h if the water heater either (1) has a storage volume ≤ 120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.

f Water heaters or gas pool heaters in this category are regulated as consumer products by the USDOE as defined in 10 C.F.R. Part 430.

g Storage water heaters have a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.

h Instantaneous water heaters and hot water supply boilers have an input capacity (Btu/h) divided by storage volume (gal) ≥ 4000 Btu/h-gal.

i There are no minimum efficiency requirements for electric heat pump water heaters greater than 12 kW or for gas heat pump water heaters.

j Refer to Section C404.2.1 for additional requirements for service water heat system equipment.

k A tabletop water heater is a storage water heater that is enclosed in a rectangular cabinet with a flat top surface not more than three feet (0.91 m) in height and have a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.

l A grid-enabled water heater is an electric resistance water heater that meets all of the following:

1. Has a rated storage tank volume of more than 75 gallons.
2. Is manufactured on or after April 16, 2015.
3. Is equipped at the point of manufacture with an activation lock.
4. Bears a permanent label applied by the manufacturer that complies with all of the following:
   4.1. Is made of material not adversely affected by water.

4.2. Is attached by means of nonwater soluble adhesive.

4.3. Advises purchasers and end-users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: "IMPORTANT INFORMATION: This water heater is intended only for use as a part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this "Public

m Unfired storage tanks shall be insulated with additional insulation beyond the minimum insulation required by Table C404.2, in accordance with Section C404.6.1.

**C404.3 Efficient heated water supply piping.** Heated water supply piping shall be in accordance with Section C404.3.1 or C404.3.2. The flow rate through 1/4-inch (6.4 mm) piping shall be not greater than 0.5 gpm (1.9 L/m). The flow rate through 5/16-inch (7.9 mm) piping shall be not greater than 1 gpm (3.8 L/m). The flow rate through 3/8-inch (9.5 mm) piping shall be not greater than 1.5 gpm (5.7 L/m). Water heaters, circulating water systems and heat trace temperature maintenance systems shall be considered sources of heated water.

**C404.3.1 Maximum allowable pipe length method.** The maximum allowable piping length from the nearest source of heater water to the termination of the fixture supply pipe shall be in accordance with the following. Where the piping contains more than one size of pipe, the largest size of pipe within the piping shall be used for determining the maximum allowable length of the piping in Table C404.3.1.

1. For a public lavatory faucet, use the "Public lavatory faucets" column in Table C404.3.1.
2. For all other plumbing fixtures and plumbing appliances, use the "Other fixtures and appliances" column in Table C404.3.1.

**Table C404.3.1**
**Piping Volume and Maximum Piping Lengths**

| Nominal Pipe Size (inches) | Volume (liquid ounces per foot length) | Maximum Piping Length (feet) | |
|---|---|---|---|
| | | Public lavatory faucets | Other fixtures and appliances |
| 1/4 | 0.33 | 6 | 50 |
| 5/16 | 0.5 | 4 | 50 |
| 3/8 | 0.75 | ((~~3~~)) 8 | 50 |
| 1/2 | 1.5 | ((~~2~~)) 8 | 43 |
| 5/8 | 2 | ((~~1~~)) 8 | 32 |
| 3/4 | 3 | 0.5 | 21 |
| 7/8 | 4 | 0.5 | 16 |
| 1 | 5 | 0.5 | 13 |
| 1-1/4 | 8 | 0.5 | 8 |
| 1-1/2 | 11 | 0.5 | 6 |
| 2 or larger | 18 | 0.5 | 4 |

**C404.3.2 Maximum allowable pipe volume method.** The water volume in the piping shall be calculated in accordance with Section C404.3.2.1.

The volume from the nearest source of heated water to the termination of the fixture supply pipe shall be as follows:

1. For a public lavatory faucet: Not more than 2 ounces (0.06 L).
2. For other plumbing fixtures or plumbing appliances; not more than 0.5 gallon (1.89 L).

**C404.3.2.1 Water volume determination.** The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the nearest source of heated water and the termination of the fixture supply pipe. The volume in the piping shall be determined from the "Volume" column in Table C404.3.1 or from Table C404.3.2.1. The volume contained within fixture shutoff valves, within flexible water supply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

**Table C404.3.2.1**
**Internal Volume of Various Water Distribution Tubing**

| Ounces of Water per Foot of Tube | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nominal Size (inches) | Copper Type M | Copper Type L | Copper Type K | CPVC CTS SDR 11 | CPVC SCH 40 | CPVC SCH 80 | PE-RT SDR | Composite ASTM F1281 | PEX CTS SDR 9 |
| 3/8 | 1.06 | 0.97 | 0.84 | N/A | 1.17 | — | 0.64 | 0.63 | 0.64 |
| 1/2 | 1.69 | 1.55 | 1.45 | 1.25 | 1.89 | 1.46 | 1.18 | 1.31 | 1.18 |
| 3/4 | 3.43 | 3.22 | 2.90 | 2.67 | 3.38 | 2.74 | 2.35 | 3.39 | 2.35 |
| 1 | 5.81 | 5.49 | 5.17 | 4.43 | 5.53 | 4.57 | 3.91 | 5.56 | 3.91 |
| 1-1/4 | 8.70 | 8.36 | 8.09 | 6.61 | 9.66 | 8.24 | 5.81 | 8.49 | 5.81 |
| 1-1/2 | 12.18 | 11.83 | 11.45 | 9.22 | 13.20 | 11.38 | 8.09 | 13.88 | 8.09 |
| 2 | 21.08 | 20.58 | 20.04 | 15.79 | 21.88 | 19.11 | 13.86 | 21.48 | 13.86 |

**C404.3.3 Demand load for Group R-2 occupancies.** Demand load for water supply of dwelling units within Group R-2 occupancies shall be determined using Appendix M of the Seattle Plumbing Code. Piping shall be no more than one pipe size larger than the minimum size permitted when sized for maximum allowable velocity based upon the specified piping material in conjunction with the Appendix M demand load flow rate at any specific node within the water distribution system.

**EXCEPTION:** Existing buildings are not required to comply with this section if the existing plumbing fixtures have higher flow rates than those listed in Table M102.1 of the Seattle Plumbing Code.

**C404.4 Heat traps for hot water storage tanks.** Storage tank-type water heaters and hot water storage tanks that have vertical water pipes connecting to the inlet and outlet of the tank shall be provided with integral heat traps at the vertical inlets and outlets or shall have pipe-configured heat traps in the piping connected to those inlets and outlets. Tank inlets and outlets associated with solar water heating system circulation loops shall not be required to have heat traps.

**C404.5 Water heater installation.** Electric water heaters in unconditioned spaces or on concrete floors shall be placed on an incompressible, insulated surface with a minimum thermal resistance of R-10.

**C404.6 Insulation of piping.** Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table ((~~C403.10.3~~)) C404.6. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet (2438 mm) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table ((~~C403.10.3~~)) C404.6 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions or Table C404.6, whichever results in thicker insulation. Pipe insulation shall be continuous, including through hangers and supports, such that thermal bridging is prevented, except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.

**EXCEPTION:** Tubular pipe insulation shall not be required on the following:

1. The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.
2. Valves, pumps, strainers and threaded unions in piping that is 1 inch (25 mm) or less in nominal diameter.
3. Piping from user-controlled shower and bath mixing valves to the water outlets.
4. ((~~Cold water piping of a demand recirculation water system.~~))
5. Tubing from a hot drinking-water heating unit to the water outlet.
6. ((~~Piping at~~)) Vertical pipe riser locations where a vertical support of the piping is installed.
7. ((~~Piping surrounded by building insulation with a thermal resistance (*R* value) of not less than R-3.~~))
8. Hot water piping that is part of the final pipe run to the plumbing fixture and is not part of the heated-water circulation system circulation path is not required to meet the minimum insulation requirements of Section C404.6.

**Table C404.6**
**Required Pipe Insulation Thickness for Service Water Heating**

| Location | Water Temp | Nominal Pipe or Tube Size | | | | | Insulation Conductivity | |
|---|---|---|---|---|---|---|---|---|
| | | < 1" | 1 to < 1-1/2" | 1-1/2 to < 4" | 4 to < 8" | 8" or larger | Conductivity Btu • in./ (h • ft$^2$ • °F)[b] | Mean Rating Temp, °F |
| Circulation Loop Piping not in-partition | 105 - 140°F | 2.0 | 2.0 | 2.5 | 2.5 | 2.5 | 0.21 - 0.28 | 100 |
| | 141 - 200°F | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 0.25 - 0.29 | 125 |
| All other piping not in-partition | 105 - 140°F | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 | 0.21 - 0.28 | 100 |
| | 141 - 200°F | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 | 0.25 - 0.29 | 125 |
| In-partition[a] Circulation Loop Piping | 105 - 140°F | 1.0 | 1.0 | 2.5 | 2.5 | 2.5 | 0.21 - 0.28 | 100 |
| | 141 - 200°F | 1.5 | 1.5 | 3.0 | 3.0 | 3.0 | 0.25 - 0.29 | 125 |
| In-partition[a] All other piping | 105 - 140°F | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 | 0.21 - 0.28 | 100 |
| | 141 - 200°F | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 | 0.25 - 0.29 | 125 |

a. In a partition within a *conditioned space*.
b. For insulation outside the stated conductivity range, conform to requirements of Table C403.10.1.

**C404.6.1 Storage tank insulation.** Unfired storage tanks used to store service hot water at temperatures above 130°F (54°C) shall be wrapped with an insulating product, installed in accordance with the insulation manufacturer's instructions and providing a minimum of R-2 additional insulation for every 10°F (5°C) increase in stored water temperature above 130°F (54°C). Such additional insulation is also permitted to be integral to the tank. The insulation is permitted to be discontinuous at structural supports.

**C404.7 Heated-water circulating and heat trace temperature maintenance systems.** Heated-water circulation systems for *temperature maintenance* shall be in accordance with Section C404.7.1. Electric resistance heat trace systems for *temperature maintenance* shall be in accordance with Section C404.7.2. Controls for hot water storage shall be in accordance with Section C404.7.3. Automatic controls, temperature sensors and pumps shall be in a location with *access*. Manual controls shall be in a location with *ready access*.

**C404.7.1 Circulation systems.** Heated-water circulation systems shall be provided with a circulation pump. The pump shall have an electronically commutated motor with a means of adjusting motor speed for system balancing. The system return pipe shall be a dedicated return pipe. Gravity and thermo-syphon circulation systems are prohibited. Controls shall start the circulation pump based on the identification of a demand for hot water within the occupancy, according to the requirements of Sections C404.7.1.1 and C404.7.1.2.

**C404.7.1.1 Single riser systems.** Where the circulation system serves only a single domestic hot water riser or zone, the following controls shall be provided:

1. Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the design supply temperature and shall not turn the pump back on until the temperature is a minimum of 10°F (5°C) lower than the design supply temperature.
2. Controls shall be equipped with a manual switch or other control method that can be used to turn off the circulating pump during extended periods when hot water is not required.

**C404.7.1.2 Multiple riser systems.** Where the circulation system serves multiple domestic hot water risers or piping zones, the following equipment and controls shall be provided:

1. Controls shall be configured to automatically turn off the circulation pump during ((~~extended~~)) periods of time exceeding 4 hours when hot water is not required. Pump circulation is permitted to be automatically started a maximum of 4 hours before scheduled occupancy time to warm up the system or may be automatically started and stopped to run a maximum of 50% of each hour to maintain water circulation to reduce legionella or other biological growth in circulation water.
2. (Reserved) ((~~System shall include means for balancing the flow rate through each individual hot water supply riser or piping zone.~~))
3. ((~~For circulation systems that use a variable flow circulation pump, each riser and piping zone shall have a self-actuating thermostatic balancing valve.~~)) At the end of each riser or piping zone before heated water is returned to the circulation pump, a thermostatic balancing valve or control valve that automatically controls the flow through the riser or piping zone to maintain the domestic hot water supply temperature in the riser at a maximum of 5°F (2.3°C) lower than the design supply water temperature.

**EXCEPTION:** Multiple riser systems serving Group R and Group I occupancies are not required to have controls that automatically turn off the circulation pump.

**C404.7.1.3 Electronic thermostatic mixing valve (TMV).** Where a heated water circulation system utilizes an electronic TMV to control the temperature of hot water supplied to the building, the TMV shall be configured so that it either reverts closed (fully COLD) or maintains its current valve position upon power failure or cessation of circulation flow.

**C404.7.2 Heat trace systems.** Electric heat trace systems shall comply with IEEE 515.1. Controls for such systems shall be able to automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy. Heat trace shall be arranged to be turned off automatically when there is no hot water demand.

**C404.7.3 Controls for hot water storage.** The controls on pumps that circulate water between a water heater and a heated-water storage tank shall limit operation of the pump from heating cycle startup to not greater than 5 minutes after the end of the cycle.

**C404.8 Demand recirculation controls.** *Demand recirculation water systems* are not permitted. ((~~shall have controls that comply with both of the following:~~

1. ~~The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.~~
2. ~~The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C)~~))

**C404.9 Domestic hot water meters.** Each individual *dwelling unit* in a Group R-2 occupancy with central service domestic hot water systems shall be provided with a domestic hot water meter to allow for domestic hot water billing based on actual domestic hot water usage.

**EXCEPTION:** *Dwelling units* in other than Group R-2 multi-family and live/work units are not required to provide domestic hot water metering at each *dwelling unit* where domestic hot water is metered separately for each of the following building end uses:

1. *Dwelling units*.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.

**C404.10 Drain water heat recovery units.** Drain water heat recovery units shall comply with CSA B55.2. Potable water-side pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. For Group R occupancies, the efficiency of drain water heat recovery unit efficiency shall be in accordance with CSA B55.1.

**C404.11 Energy consumption of pools and permanent spas.** The energy consumption of pools and permanent spas shall be controlled by the requirements in Sections C404.11.1 through C404.11.4.

**C404.11.1 Heaters.** 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 (10°C) db, 44.2°F (6.8°C) wb outdoor air and 80°F (27°C) entering water, determined in accordance with AHRI 1160. Other pool heating equipment shall comply with the applicable efficiencies in Section C404.2.

The electric power to all heaters shall be controlled by an on-off switch that is an integral part of the heater, mounted on the exterior of the heater, or external to and within 3 feet of the heater in a location with *ready access*. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with constant burning pilot lights.

**C404.11.2 Time switches.** Time switches or other control method that can automatically turn off and on heaters and pump motors according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

**EXCEPTIONS:**

1. Where public health standards require 24-hour pump operation.
2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

**C404.11.3 Covers.** Heated pools and permanent spas shall be provided with a vapor-retardant cover on or at the water surface. Pools heated to more than 90°F shall have a pool cover with a minimum insulation value of R-12, and the sides and bottom of the pool shall also have a minimum insulation value of R-12.

**C404.11.4 Heat recovery.** Heated indoor swimming pools, spas or hot tubs with water surface area greater than 200 square feet shall provide for energy conservation by an exhaust air heat recovery system that heats ventilation air, pool water or domestic hot water. The heat recovery system shall be configured to decrease the exhaust air temperature at design heating conditions (80°F indoor) by 36°F (10°C).

**EXCEPTION:** Pools, spas or hot tubs that include system(s) that provide equivalent recovered energy on an annual basis through one of the following methods:

1. Solar water heating systems not claimed in Section ((~~C406.5 or~~)) C406.2.5, C407, or C411;
2. Dehumidification heat recovery;
3. Waste heat recovery; or
4. A combination of these system sources capable of and configured to provide at least 70 percent of the heating energy required over an operating season.

**C404.12 Portable spas.** The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

**C404.13 Service water pressure-booster systems.** Service water pressure-booster systems shall be designed and configured such that the following apply:

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operations of remote sensors.
2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, except for safety devices.
3. Booster system pumps shall not operate when there is no service water flow except to refill hydro-pneumatic tanks.
4. System pump motors 5.0 hp and greater shall be provided with variable flow capacity in accordance with Section C403.2.4.

**C404.14 Demand responsive water heating.** Electric storage water heaters with rated water storage volume between 40 and 120 gallons and a nameplate input rating equal to or less than 12kW shall be provided with *demand responsive controls* that comply with ANSI/CTA-2045-B Level 2 or another equivalent *approved demand responsive control*.

**EXCEPTIONS:**

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use three-phase electric power.
4. Storage water heaters with *demand responsive controls* that comply with ANSI/CTA 2045-A or ANSI/CTA 2045-B Level 1, that are also capable of initiating water heating to meet the temperature setpoint in response to a *demand response signal*.

**C404.15 Commissioning.** Service water heating systems shall be commissioned in accordance with Section C408.

## SECTION C405
## ELECTRICAL POWER AND LIGHTING SYSTEMS

**C405.1 General.** Lighting system controls, the maximum lighting power for interior and exterior applications, electrical energy consumption, vertical and horizontal transportation systems, and minimum efficiencies for motors and transformers shall comply with this section. Receptacles shall be controlled according to Section C405.10. *Controlled receptacles* and lighting systems shall be commissioned according to Section C405.12. Solar readiness shall be provided according to Section C411.3 and renewable energy shall be provided according to Sections C411.1, C411.2, and C412.

*Dwelling units* shall comply with Sections C405.1.1 and C405.7.

*Sleeping units* shall comply with Section C405.2.6, item 2 and Section C405.1.1 or Section C405.4.

*General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.4.1 and which does not require specific application controls in accordance with Section C405.2.5.

Lighting installed in *walk-in coolers*, *walk-in freezers*, *refrigerated warehouse coolers* and *refrigerated warehouse freezers* shall comply with the lighting requirements of Section C410.2.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in *data center systems* shall comply with Section 8 of ASHRAE Standard 90.4 in addition to this code.

**EXCEPTION:** Energy using equipment used by a manufacturing, industrial or commercial process other than maintaining comfort and amenities for the occupants are exempt from all Section C405 subsections except Section C405.8. Data center and computer room HVAC equipment is not covered by this exemption.

**C405.1.1 Lighting for dwelling and sleeping units.** No less than 90 percent of the permanently installed lighting serving *dwelling units* or *sleeping units*, excluding kitchen appliance lighting, shall be provided by lamps with a minimum efficacy of 65 lumens per watt or luminaires with an efficacy of not less than 45 lumens per watt.

**C405.2 Lighting controls.** Lighting systems shall be provided with controls that comply with one of the following:

1. Lighting controls as specified in Sections C405.2.1 through C405.2.10.
2. *Luminaire-level* lighting controls (LLLC) as specified in Section C405.2.8.1.

**EXCEPTION:** Except for specific application controls required by Section C405.2.6, lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Means of egress illumination serving the exit access that does not exceed 0.01 watts per square foot of building area.
3. Emergency egress lighting that is normally off.
4. Industrial or manufacturing process areas, as may be required for production and safety.

**C405.2.1 Occupant sensor controls.** Occupant sensor controls shall be installed to control luminaires in the space types listed in Table C405.2.1, and shall comply with the requirements listed in the table.

**EXCEPTIONS:**

1. Corridors in manufacturing facilities.
2. *General lighting* and task lighting in shop and laboratory classrooms.
3. Luminaires that are required to have specific application controls in accordance with Section C405.2.6 unless specifically required to comply with this section by Section C405.2.6.

**Table C405.2.1**
**Occupant sensor control locations**

| Space types[a] | Comply with Section |
|---|---|
| Classrooms/lecture/training rooms | C405.2.1.1 |
| Conference/meeting/multipurpose rooms | C405.2.1.1 |
| Copy/print rooms | C405.2.1.1 |
| Lounge/breakrooms | C405.2.1.1 |
| Enclosed offices | C405.2.1.1 |
| Open plan office areas | C405.2.1.3 |
| Restrooms | C405.2.1.1 |
| Storage rooms | C405.2.1.1 |
| Locker rooms | C405.2.1.1 |
| Other spaces 300 square feet (28 $m^2$) or less that are enclosed by floor-to-ceiling height partitions | C405.2.1.1 |
| Warehouse storage areas | C405.2.1.2 |
| Library stacks | C405.2.1.2 |
| Enclosed fire rated stairways | ((~~C405.2.1.5~~)) C405.2.1.4 |
| Corridors | ((~~C405.2.1.6~~)) C405.2.1.5 |
| Covered parking | C405.2.10 |

a. The space types listed include other spaces with substantially similar uses.

**C405.2.1.1 Occupant sensor control function.** Occupant sensor controls for the space types listed in Section C405.2.1 shall comply with all of the following:

1. They shall be configured to automatically turn off lights within 20 minutes of all occupants leaving the space.
2. They shall be manual on or configured to automatically turn the lighting on to not more than 50 percent power.

   **EXCEPTION:** Full automatic-on controls with no manual control shall be permitted in corridors, interior parking areas, stairways, restrooms, locker rooms, library stacks, lobbies, and areas where manual operation would endanger occupant safety or security.

3. They shall incorporate a manual control to allow occupants to turn lights off.

   ((~~**EXCEPTION:** Full automatic-on controls with no manual control shall be permitted in corridors, interior parking areas, stairways, restrooms, locker rooms, library stacks, lobbies, and areas where manual operation would endanger occupant safety or security.~~

4. ~~They shall incorporate a manual control to allow occupants to turn lights off.~~))

**C405.2.1.2 Occupant sensor control function in warehouse storage areas and library stacks.** Lighting in library stacks and warehouse storage areas shall be controlled as follows.

1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an unoccupied setpoint of not more than 50 percent of full power within 20 minutes after all occupants have left the controlled area.
3. Lights which are not turned off by occupant sensors shall ((~~be turned off by time schedule sweep to turn lighting off within 20 minutes of all occupants leaving the space, or~~)) comply with Section C405.2.2 to turn lighting off when the building is vacant.
4. Restore lighting to full power or target light level when occupants enter the space.
5. A *manual* control shall be provided to allow occupants to turn off lights in the space.

**C405.2.1.3 Occupant sensor control function in open plan office areas.** Occupant sensor controls in open plan office spaces less than 300 square feet (28 $m^2$) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall be configured to comply with all of the following:

1. *General lighting* is controlled separately in control zones with floor areas not greater than 600 square feet (55 $m^2$) within the open plan office space.
2. *General lighting* in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. *General lighting* in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.
3. Automatically turn off *general lighting* in all control zones within 20 minutes after all occupants have left the open plan office space.
4. *General lighting* in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.
5. Lighting controls in open plan office areas larger than 5,000 square feet must also comply with Section C405.2.8.

**C405.2.1.4 Occupant sensor control function in enclosed fire rated stairways.** Occupant sensor controls shall be configured to automatically reduce lighting power by not less than 50 percent when no occupants have been detected in the stairway for a period not exceeding 20 minutes and restore lighting to full power when occupants enter the stairway. All portions of stairways shall remain illuminated to meet the requirements of ((~~Section 1009~~)) Sections 1008 and 1025 of the *International Building Code* when the lighting power is reduced.

**C405.2.1.5 Occupant sensor control function in corridors.** Occupant sensor controls in *corridors* shall uniformly reduce lighting power to an unoccupied setpoint of not more than 50 percent of full power within 20 minutes after all occupants have left the space.

**EXCEPTION:** *Corridors* provided with less than two foot-candles of illumination on the floor at the darkest point with all lights on.

**C405.2.2 Time switch controls.** Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 through Section C405.2.1.5 shall be provided with time switch controls complying with Section C405.2.2.1.

**EXCEPTIONS:**

1. Luminaires which are required to have specific application controls in accordance with Section C405.2.6 unless specifically required to comply with this section by Section C405.2.6.
2. Spaces where patient care is directly provided.
3. Spaces where an automatic shutoff would endanger occupant safety or security.
4. Lighting intended for continuous operation.
5. Shop and laboratory classrooms.

**C405.2.2.1 Time switch control function.** Time switch controls shall provide programmed shutoff for lighting when building areas are unoccupied and shall comply with the following:

1. Have a minimum 7 day clock.
2. Be capable of being set for 7 different day types per week.
3. Incorporate an automatic holiday "shut-off" feature, which turns off all controlled lighting loads for at least 24 hours and then resumes normally scheduled operations.
4. Have program back-up capabilities, which prevent the loss of program and time settings for at least 10 hours, if power is interrupted.

5. Include an override switching device that complies with the following:
   5.1. The override switch shall be a *manual* control.
   5.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.
   5.3. Any individual override switch shall control the lighting for an area not larger than ((~~5,000~~)) 2,500 square feet (((~~465~~)) 232 $m^2$).
6. Time switch controls are allowed to automatically turn on lighting to full power in corridors, lobbies, restrooms, storage rooms less than 50 square feet, and medical areas of health care facilities. In all other spaces, time switch controls are allowed to automatically turn on the lighting to not more than 50 percent power.

**EXCEPTION:** Within mall concourses, auditoriums, sales areas, manufacturing facilities, pools, gymnasiums, skating rinks, and sports arenas:

1. The time limit shall be permitted to be greater than 2 hours provided the switch is a captive key device.
2. The area controlled by the override switch shall not be limited to 5,000 square feet (465 $m^2$), provided that such area is less than 20,000 square feet (1860 $m^2$).

**C405.2.3 Manual controls.** Stairwells and parking garages are not permitted to use manual switches. All other lighting shall have *manual* controls complying with the following:

1. They shall be in a location with *ready access* to occupants.
2. They shall be located where the controlled lights are visible, or shall identify the area served by the lights and indicate their status.
3. Each control device shall control an area no larger than a single room, or 2,500 square feet, whichever is less, if the room area is less than or equal to 10,000 square feet, or one-quarter of the room area or 10,000 square feet, whichever is less, if the room area is greater than 10,000 square feet.

**EXCEPTIONS:**

1. A *manual* control may be installed in a remote location for the purpose of safety or security provided each remote control device has an indicator pilot light as part of or next to the control device and the light is clearly labeled to identify the controlled lighting.
2. Restrooms.

**C405.2.4 Light reduction controls.** Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.4.1.

**Exceptions:**

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.5.
2. Luminaires controlled by special application controls complying with Section C405.2.6.
3. Where provided with manual control, the following areas are not required to have light reduction control:
   3.1. Spaces that have only one luminaire with a rated power of less than 60 watts.
   3.2. Spaces that use less than 0.45 watts per square foot (4.9 $W/m^2$)
   3.3. Corridors, lobbies, electrical rooms and/or mechanical rooms.

**C405.2.4.1 Light reduction control function.** Manual controls shall be configured to provide light reduction control that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonable uniform illumination pattern with an intermediate step in addition to full on or off, or with continuous dimming control, by using one of the following or another approved method:

1. Continuous dimming of all luminaires from full output to less than 20 percent of full power.
2. Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.
3. Switching alternate rows of luminaires or alternate luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.

**C405.2.5 Daylight responsive controls.** *Daylight responsive controls* complying with Section C405.2.5.1 shall be provided to control the *general lighting* within *daylight zones* in the following spaces:

1. Spaces with a total of more than 75 watts of *general lighting* within *primary sidelit daylight zones* complying with Section C405.2.5.2.
2. Spaces with a total of more than 150 watts of *general lighting* within the combined *primary* and *secondary daylight zones* complying with Section C405.2.5.2.

3. Spaces with a total of more than 75 watts of *general lighting* within *toplit daylight zones* complying with Section C405.2.5.3.

**EXCEPTION:** *Daylight responsive controls* are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.
2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies where the fenestration adjoins a sidewalk or other outdoor pedestrian area, provided that the light fixtures are controlled separately from the general area lighting.

**C405.2.5.1 Daylight responsive controls function.** Where required, daylight responsive controls shall be provided within each space for control of lights in that space and shall comply with all of the following:

1. Lights in primary sidelit daylight zones shall be controlled independently of lights in secondary sidelit daylight zones in accordance with Section C405.2.5.2.
2. Lights in toplit daylight zones in accordance with Section C405.2.5.3 shall be controlled independently of lights in sidelit daylight zones in accordance with Section C405.2.5.2.
3. *Daylight responsive controls* within each space shall be configured so that they can be calibrated from within that space by authorized personnel.
4. Calibration mechanisms shall be in a location with *ready access*.
5. *Daylight responsive controls* shall dim lights continuously from full light output to 15 percent of full light output or lower.
6. *Daylight responsive controls* shall be configured to completely shut off all controlled lights in that zone.
7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through ((~~C405.2.1.4~~)) C405.2.1.5, *daylight responsive controls* shall continue to adjust electric light levels in response to available daylight but shall be configured to not increase the lighting power above the specified unoccupied setpoint.
8. Lights in sidelit daylight zones in accordance with Section C405.2.5.2 facing different cardinal orientations (i.e., within 45 degrees of due north, east, south, west) shall be controlled independently of each other.

   **EXCEPTION:** Up to 75 watts of *general lighting* are permitted to be controlled together with lighting in a daylight zone facing a different cardinal orientation.
9. Incorporate time-delay circuits to prevent cycling of light level changes of less than three minutes.
10. The maximum area a single *daylight responsive control* device serves shall not exceed 2,500 square feet (232 $m^2$) and no more than 60 lineal feet (18.3 m) of facade.
11. Occupant override capability of daylight dimming controls is not permitted, other than a reduction of light output from the level established by the daylighting controls.
12. *Daylight responsive controls* shall be set initially to activate at 30 footcandles (323 lux) or not more than 110 percent of the illuminance level specified on the construction documents.

**C405.2.5.1.1 Dimming.** *Daylight responsive controls* shall be configured to automatically reduce the power of *general lighting* in the *daylight zone* in response to available daylight, while maintaining *uniform illumination* in the space through ((~~one of the following methods:~~))

1. Continuous dimming using dimming ballasts/dimming drivers and daylight-sensing *automatic* controls. The system shall reduce lighting power continuously to less than ((~~15~~)) 10 percent of rated power at maximum light output.
2. ((~~Stepped dimming using multi-level switching and daylight sensing controls. The system shall provide a minimum of two steps of uniform illumination between 0 and 100 percent of rated power at maximum light output. Each step shall be in equal increments of power, plus or minus 10 percent.~~

~~General lighting within *daylight zones* in offices, classrooms, laboratories and library reading rooms shall use the continuous dimming method. Stepped dimming is not allowed as a method of *daylight zone* control in these spaces.~~))

**C405.2.5.2 Sidelit daylight zone.** The sidelit daylight zone is the floor area adjacent to vertical *fenestration* which complies with the following:

1. Where the *fenestration* is located in a wall, the primary sidelit daylight zone shall extend laterally to the nearest full height wall, or up to 1.0 times the height from the floor to the top of the *fenestration*, and longitudinally from the edge of the *fenestration* to the nearest full height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.5.2(1).
2. The secondary sidelit daylight zone is directly adjacent to the primary daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the *fenestration* or to the nearest full height wall, whichever is

less, and longitudinally from the edge of the *fenestration* to the nearest full height wall or up to ((~~2 feet~~)) 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.5.2(1).

3. Where *clerestory fenestration* is located in a wall, the sidelit daylight zone includes a lateral area twice the depth of the *clerestory fenestration* height, projected upon the floor at a 45 degree angle from the center of the *clerestory fenestration*. The longitudinal width of the sidelit daylight zone is calculated the same as for *fenestration* located in a wall. Where the 45 degree angle is interrupted by an obstruction greater than 0.7 times the ceiling height, the sidelit daylight zone shall remain the same lateral area but be located between the clerestory and the obstruction, as indicated in Figure C405.2.5.2(2).
4. Where the *fenestration* is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the *fenestration*, whichever is less, and longitudinally from the edge of the *fenestration* to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the *fenestration*, whichever is less, as indicated in Figures C405.2.5.2(3) and C405.2.5.2(4).
5. If the rough opening area of a vertical fenestration assembly is less than 10 percent of the calculated primary sidelit daylight zone area for this fenestration, it does not qualify as a sidelit daylight zone.
6. The visible transmittance of the fenestration is no less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection which is shading the *fenestration* is not greater than 1.0 for fenestration oriented 45 degrees or less from true north, and not greater than 1.5 for all other orientations.

**Figure C405.2.5.2(1)**
**Sidelit Daylight Zone Adjacent to Fenestration in a Wall**

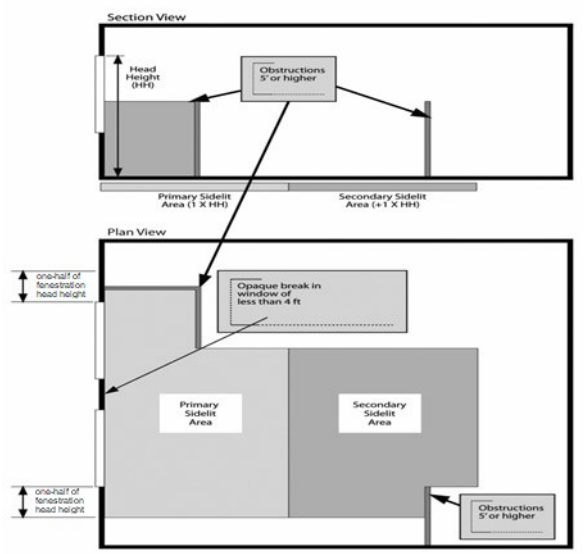



**Figure C405.2.5.2(2)**
**Sidelit Daylight Zone Adjacent to Clerestory Fenestration in a Wall**

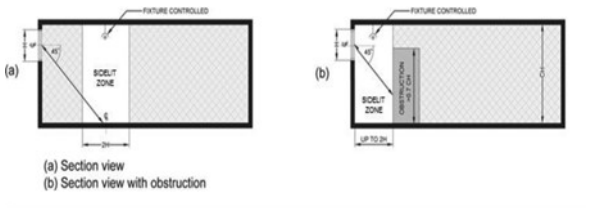
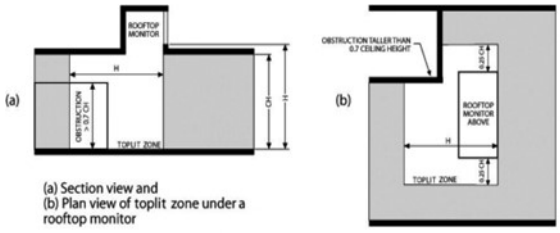
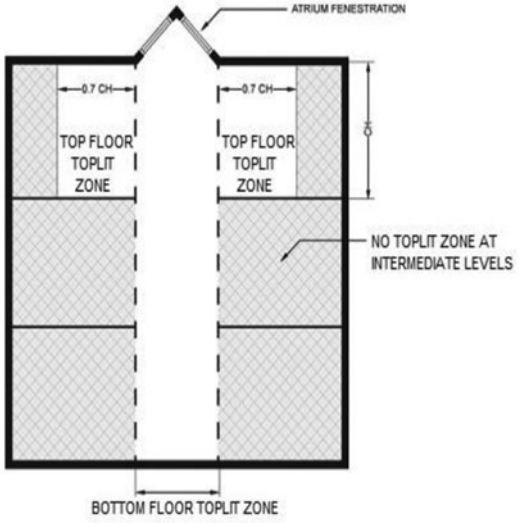


**Figure C405.2.5.3(2)**
**Toplit Daylight Zone Under a Rooftop Monitor**




(a) Section view and
(b) Plan view of toplit zone under a rooftop monitor

**Figure C405.2.5.4**
**Toplit Daylight Zone Under Atrium Fenestration**




**C405.2.5.4 Atriums.** Daylight zones at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.5.4.

**C405.2.6 Additional lighting controls.** Specific application lighting shall be provided with controls, in addition to controls required by other sections, for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time switch control complying with Section C405.2.2.1. In addition, a *manual* control shall be provided to control such lighting separately from the *general lighting* in the space:
   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.4.2.2.1.
   1.2. Display and accent.
   1.3. Lighting in display cases.
   1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
   1.5. Lighting equipment that is for sale or demonstration in lighting education.
   1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.
2. *Sleeping units* shall have control device(s) or systems configured to automatically switch off all permanently installed luminaires and switched receptacles, <u>including those installed within furniture,</u> within 20 minutes after all occupants have left the unit.

   **EXCEPTIONS:**

   1. Lighting and switched receptacles controlled by card key controls.
   2. Spaces where patient care is directly provided.

3. Lighting for life support of ((~~nonhuman life forms~~)) plants and animals and food warming, shall be controlled by a dedicated control that is independent of the controls for other lighting within the room or space. ((~~Each control zone shall be no greater than the area served by a single luminaire or 4,000 square feet (372 $m^2$), whichever is larger.~~))
4. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a manual control.
5. Luminaires serving the exit access and providing means of egress illumination required by Section 1008.2 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 0.01 watts per square foot (0.108 $W/m^2$) of building area is exempt from this requirement.

**SDCI Informative Note:** The term "exit access" is described in Chapter 10 of the International Building Code, and generally includes all portions of an egress pathway leading to an "exit," which is typically an exterior door or a fire-rated stair enclosure.

**C405.2.7 Area controls.** The maximum lighting power that may be controlled from a single switch or automatic control device shall not exceed that which is provided by a 20 ampere circuit loaded to not more than 80 percent. A master control may be installed provided the individual switches retain their capability to function independently. Circuit breakers may not be used as the sole means of switching.

**EXCEPTION:** Areas less than 5 percent of the building footprint for footprints over 100,000 $ft^2$.

**C405.2.8 Advanced lighting controls.** Any contiguous open office area larger than 5,000 square feet shall have its *general lighting* controlled by either:

1. *Luminaire-level lighting controls* (LLLC) conforming to the requirements of Section C405.2.8.1.
2. Networked lighting control (NLC) conforming to the requirements of Section C405.2.8.2.

**C405.2.8.1 Luminaire-level lighting controls.** Where *luminaire-level lighting controls* are required, they shall be configured to provide the controls or equivalent control function specified in Sections C405.2.1, C405.2.3, and C405.2.5. In addition, each LLLC luminaire shall be independently configured to:

1. Provide for continuous full range dimming.
2. Monitor occupant activity to brighten or dim lights when occupied or unoccupied, respectively.
3. Monitor ambient lighting, both electric and daylight, and brighten or dim artificial light to maintain desired light level. A maximum of 8 fixtures are permitted to be controlled together to maintain uniform light levels within a single daylight zone.
4. Allow configuration and reconfiguration of performance parameters for each control strategy including: High trim and low trim setpoints, timeouts, dimming fade rates, and sensor sensitivity adjustment.
5. Construction documents shall include a submittal of a sequence of operations including a specification outlining each of the functions required by this section.
6. Luminaires shall be configured with high end trim in accordance with Section C405.2.8.3.

**C405.2.8.2 Networked lighting control (NLC).** Where NLC are required, they shall be configured to provide controls and minimum function as specified in Section C405.2. In addition, each NLC luminaire shall be independently configured to:

1. Provide for continuous full range dimming.
2. Each luminaire shall be individually addressed.

   **EXCEPTIONS TO ITEM 2:**

   1. Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.
   2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet.
   3. Monitor occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   4. Monitor ambient lighting, both electric and daylight, and brighten or dim artificial light to maintain desired light level. A maximum of 8 fixtures are permitted to be controlled together to maintain uniform light levels within a single daylight zone.

3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

**EXCEPTIONS TO ITEM 3:**

1. Daylight transition lighting for covered vehicle entrances and exits from buildings and parking structures; each transition zone shall not exceed a depth of 66 feet inside the structure and a width of 50 feet.
2. Where permanent screens or architectural elements obstruct more than 50 percent of the opening.
3. Where the top of any existing adjacent structure or natural object is at least twice as high above the openings as its horizontal distance from the opening.

**C405.3 Lighting for plant growth and maintenance.** ((~~All~~)) In Group F, Group U, and *controlled plant growth environments*, all permanently installed luminaires used for plant growth and maintenance shall have a *photosynthetic photon efficacy* measured at the lamp for luminaires with serviceable or removable lamps or at the luminaire for integrated, nonserviceable luminaires of not less than 1.7 µmol/J for greenhouses and not less than 1.9 µmol/J for all other indoor growing spaces as defined in accordance with ANSI/ASABE S640.

**EXCEPTION:** Buildings with no more than 10 kW of aggregate horticultural lighting load.

Luminaires used for the growth and maintenance of plants for decorative purposes, in spaces not primarily used for horticulture, shall have a *photosynthetic photon efficacy* measured at the luminaire of not less than 1.4 µmol/J.

**C405.4 Interior lighting power requirements.** A building complies with this section if its total connected interior lighting power calculated under Section C405.4.1 is no greater than the interior lighting power allowance calculated under Section C405.4.2.

**C405.4.1 Total connected interior lighting power.** The total connected interior lighting power shall be determined in accordance with Equation 4-13.

$$TCLP = [LVL + BLL + TRK + POE + Other] \quad \textbf{(Equation 4-13)}$$

Where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp, which must be minimum 60 lumens/watt.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating the lamp.

TRK = For lighting track, cable conductor, rail conductor and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 16 W/lin. ft. (52 W/lin. m).
2. The wattage limit of the permanent current limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

POE = For other modular lighting systems served with power supplied by a driver, power supply for transformer including, but not limited to, low-voltage lighting systems, the wattage of the system shall be the maximum rated input wattage of the driver, power supply or transformed published in the manufacturer's catalogs, as specified by UL 2108 or 8750. For power-over-Ethernet lighting systems, power provided to installed nonlighting devices may be subtracted from the total power rating of the power-over-Ethernet systems.

Other = The wattage of all other luminaires and lighting, sources not covered above and associated with interior lighting verified by data supplied by the manufacturer or other approved sources.

The connected power associated with the following lighting equipment is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.
2. Emergency lighting automatically off during normal building operation.
3. Lighting in spaces specifically designed for use by occupants with special lighting needs including those with visual impairment and other medical and age-related issues.
4. Casino gaming areas.
5. General area lighting power in industrial and manufacturing occupancies dedicated to the inspection or quality control of goods and products.
6. Mirror lighting in dressing rooms.
7. Task lighting for medical and dental purposes that is in addition to *general lighting*.
8. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.

9. Lighting for theatrical purposes, including performance, stage, film production and video production.
10. Lighting for photographic processes.
11. Lighting integral to equipment or instrumentation and installed by the manufacturer.
12. ((~~Task lighting for plant growth or maintenance where the lamp efficacy is not less than 90 lumens per watt.~~)) Lighting provided exclusively for plant growth and maintenance, in spaces other than Group F, Group U, or *controlled plant growth environments*, where controlled separately from general lighting using an automatic time clock system, with rated fixture efficacy in compliance with Section C405.3.
13. Advertising signage or directional signage.
14. Lighting for food warming.
15. Lighting equipment that is for sale.
16. Lighting demonstration equipment in lighting education facilities.
17. Lighting *approved* because of safety considerations.
18. Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions.
19. Furniture mounted supplemental task lighting that is controlled by automatic shutoff.
20. Exit signs.
21. Lighting used for aircraft painting.
22. Antimicrobial lighting used for the sole purpose of disinfecting a space.

**C405.4.2 Interior lighting power allowance.** The total interior lighting power allowance (watts) for an entire building shall be determined according to Table C405.4.2(1) using the Building Area Method, or Table C405.4.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a building shall be determined according to Table C405.4.2(2) using the Space-by-Space Method. Buildings with unfinished spaces shall use the Space-by-Space Method.

**C405.4.2.1 Building area method.** For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.4.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.
2. Determine the floor area for each building area type listed in Table C405.4.2(1) and multiply this area by the applicable value from Table C405.4.2(1) to determine the lighting power (watts) for each building area type.
3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

**C405.4.2.2 Space-by-Space Method.** Where a building has a space designated as unfinished, neither the area nor the lighting power in the space shall be calculated as part of the LPA. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each area enclosed by partitions that are not less than 80 percent of the ceiling height determine the applicable space type from Table C405.4.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space shall be broken up into smaller subspaces, each using their own space type. If an entire space has multiple functions that necessitate a higher lighting power allowance in order to serve one of the primary functions, the higher allowance is permitted to be used.
2. Determine the total floor area of all of the spaces of each space type and multiply by the value for the space type in Table C405.4.2(2) to determine the lighting power (watts) for each space type.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

**C405.4.2.2.1 Additional interior lighting power.** Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed in addition to and automatically controlled separately from *general lighting*, in accordance with Section C405.2.6. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose.

An increase in the interior lighting power allowance is permitted for lighting equipment to be installed in sales areas specifically to highlight merchandise. The additional lighting power shall be determined in accordance with Equation 4-14.

$$\text{Additional Interior Lighting Power Allowance} = 500 \text{ watts} + (\text{Retail Area 1} \times 0.45 \text{ W/ft}^2) + (\text{Retail Area 2} \times 0.45 \text{ W/ft}^2) + (\text{Retail Area 3} \times 1.05 \text{ W/ft}^2) + (\text{Retail Area 4} \times 1.87 \text{ W/ft}^2) \quad \textbf{(Equation 4-14)}$$

Where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

**EXCEPTION:** Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display requirement is *approved* by the code official.

**Table C405.4.2(1)**
**Interior Lighting Power Allowances—Building Area Method**

| Building Area Type | ((~~LPD (w/ft$^2$)~~) | LPD (w/ft$^2$) |
|---|---|---|
| Automotive facility | ~~0.64~~ | 0.69 |
| Convention center | ~~0.64~~ | 0.61 |
| Court house | ~~0.79~~ | 0.71 |
| Dining: Bar lounge/leisure | ~~0.79~~ | 0.70 |
| Dining: Cafeteria/fast food | ~~0.72~~ | 0.67 |
| Dining: Family | ~~0.71~~ | 0.62 |
| Dormitory ((~~a, b~~)) | ~~0.46~~ | 0.49 |
| Exercise center | ~~0.67~~ | 0.68 |
| Fire station ((~~a~~)) | ~~0.54~~ | 0.53 |
| Gymnasium | ~~0.75~~ | 0.71 |
| Health care clinic | ~~0.70~~ | 0.77 |
| Hospital ((~~a~~)) | ~~0.84~~ | 0.92 |
| Hotel/motel ((~~a, b~~)) | ~~0.56~~ | 0.50 |
| Library | ~~0.83~~ | 0.79 |
| Manufacturing facility | ~~0.82~~ | 0.78 |
| Motion picture theater | ~~0.44~~ | 0.41 |
| Multifamily[c] | ~~0.41~~ | 0.44 |
| Museum | ~~0.55~~ | 0.53 |
| Office | ~~0.64~~ | 0.59 |
| Parking garage | ~~0.14~~ | 0.16 |
| Penitentiary | ~~0.65~~ | 0.65 |
| Performing arts theater | ~~0.84~~ | 0.78 |
| Police station | ~~0.66~~ | 0.59 |
| Post office | ~~0.65~~ | 0.61 |
| Religious building | ~~0.67~~ | 0.63 |
| Retail | ~~0.84~~ | 0.74 |
| School/university | ~~0.70~~ | 0.67 |
| Sports arena | ~~0.62~~ | 0.69 |
| Town hall | ~~0.69~~ | 0.64 |
| Transportation | ~~0.50~~ | 0.53 |
| Warehouse | ~~0.40~~ | 0.43 |
| Workshop | ~~0.91~~)) | 0.82 |

a. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

b. Where *dwelling units* are excluded from lighting power calculations by application of Section R404.1, neither the area of the *dwelling units* nor the wattage of lighting in the *dwelling units* is counted.

c. *Dwelling units* are excluded. Neither the area of the *dwelling units* nor the wattage of lighting in the dwelling units is counted.

**Table C405.4.2(2)**
**Interior Lighting Power Allowances—Space-by-Space Method**

| Common Space-by-Space Types[a] | ~~((LPD (w/ft$^2$)~~ | LPD (w/ft$^2$) |
|---|---|---|
| Atrium - Less than 20 feet in height | ~~0.39~~ | 0.30 |
| Atrium - 20 to 40 feet in height | ~~0.48~~ | 0.39 |
| Atrium - Above 40 feet in height | ~~0.60~~ | 0.48 |
| Audience/seating area - Permanent | | |
| In an auditorium | ~~0.61~~ | 0.54 |
| In a gymnasium | ~~0.23~~ | 0.22 |
| In a motion picture theater | ~~0.27~~ | 0.26 |
| In a penitentiary | ~~0.67~~ | 0.56 |
| In a performing arts theater | ~~1.16~~ | 1.04 |
| In a religious building | ~~0.72~~ | 0.68 |
| In a sports arena | ~~0.33~~ | 0.26 |
| Otherwise | ~~0.23~~ | 0.22 |
| Banking activity area~~((n))~~ i | ~~0.61~~ | |
| Breakroom (see lounge/breakroom) | | |
| Classroom/lecture hall/training room | | |
| In a penitentiary | ~~0.89~~ | 0.74 |
| Otherwise~~((m))~~ h | ~~0.71m~~ | 0.68 |
| *Computer room*, *data center* | ~~0.94~~ | 0.71 |
| Conference/meeting/multipurpose | ~~0.97~~ | 0.84 |
| Copy/print room | ~~0.31~~ | 0.53 |
| Corridor | | |
| In a facility for the visually impaired (and not used primarily by the staff)[b] | ~~0.71~~ | 0.71 |
| In a hospital | ~~0.71~~ | 0.61 |
| Otherwise[c, k] | ~~0.41~~ | 0.42 |
| Courtroom[c] | ~~1.20~~ | 1.03 |
| Dining area | | |
| In a penitentiary | ~~0.42~~ | 0.35 |
| In a facility for the visually impaired (and not used primarily by the staff)[b] | ~~1.27~~ | 1.22 |
| In a bar/lounge or leisure dining~~((n))~~ i | ~~0.86~~ | 0.72 |
| In cafeteria or fast food dining | ~~0.40~~ | 0.34 |
| In a family dining area[n] | ~~0.60~~ | 0.49 |
| Otherwise | ~~0.43~~ | 0.40 |
| Electrical/mechanical | ~~0.43~~ | 0.64 |
| Emergency vehicle garage | ~~0.52~~ | 0.48 |
| Food preparation | ~~1.09~~ | 1.13 |
| Laboratory | | |
| In or as a classroom | ~~1.11~~ | 1.00 |
| Otherwise | ~~1.33~~ | 1.14 |
| Laundry/washing area | ~~0.53~~ | 0.48 |
| Loading dock, interior | ~~0.88~~ | 0.83 |

**Table C405.4.2(2)—continued**
**Interior Lighting Power Allowances—Space-by-Space Method**

| Common Space-by-Space Types[a] | ((~~LPD (w/ft$^2$)~~) | LPD (w/ft$^2$) |
|---|---|---|
| Lobby[c] | | |
| In a facility for the visually impaired (and not used primarily by the staff)[b] | ~~1.69~~ | 1.44 |
| For an elevator | ~~0.65~~ | 0.61 |
| In a hotel | ~~0.51~~ | 0.46 |
| In a motion picture theater | ~~0.23~~ | 0.19 |
| In a performing arts theater | ~~1.25~~ | 1.14 |
| Otherwise | ~~0.84~~ | 0.76 |
| Locker room | ~~0.52~~ | 0.41 |
| Lounge/breakroom((~~n~~)) i | | |
| In a health care facility((~~n~~)) c, i | ~~0.42~~ | 0.77 |
| Otherwise((~~n~~)) i | ~~0.59~~ | 0.52 |
| Office | | |
| Enclosed | ~~0.74~~ | 0.69 |
| Open plan | ~~0.61~~ | 0.53 |
| Parking area, interior | ~~0.15~~ | 0.10 |
| Pharmacy area | ~~1.66~~ | 1.59 |
| Restroom | | |
| In a facility for the visually impaired (and not used primarily by the staff)[b] | ~~1.26~~ | 0.96 |
| Otherwise((~~n~~)) i | ~~0.63~~ | 0.70 |
| Sales area | ~~1.05~~ | 0.81 |
| Seating area, general | ~~0.23~~ | 0.20 |
| ((~~Stairway (see space containing stairway)~~)) | | |
| Security screening general area | | 0.64 |
| Security screening in transportation facilities | | 0.93 |
| Security screening transportation waiting area | | 0.56 |
| Stairwell((~~n~~)) c, i | ~~0.49~~ | 0.45 |
| Storage room | | |
| < 50 ft$^2$ | | 0.47 |
| 50-100 ft$^2$ | | |
| All other storage | ~~0.38~~ | 0.33 |
| Vehicular maintenance | ~~0.60~~ | 0.56 |
| Workshop | ~~1.26~~ | 1.11 |
| **Building Specific Space-by-Space Types[a]** | **~~LPD (w/ft$^2$)~~** | |
| Automotive (see vehicular maintenance) | | |
| Convention center - Exhibit space | ~~0.61~~ | 0.48 |
| Facility for the visually impaired[b] | | |
| In a chapel (and not used primarily by the staff)[b] | ~~0.70~~ | 0.58 |
| In a recreation room (and not used primarily by the staff)[b] | ~~1.77~~ | 1.20 |
| ((~~Fire stations[g]~~ ~~Sleeping quarters~~)) | ~~0.23~~ | |

**Table C405.4.2(2)—continued**
**Interior Lighting Power Allowances—Space-by-Space Method**

| Common Space-by-Space Types[a] | ((~~LPD (w/ft$^2$)~~) | LPD (w/ft$^2$) |
|---|---|---|
| Gaming establishments | | |
| High limits game | | 1.60 |
| Slots | | 0.51 |
| Sportsbook | | 0.78 |
| Table games | | 1.04 |
| Gymnasium/fitness center | | |
| In an exercise area | ~~0.90~~ | 0.78 |
| In a playing area | ~~0.85~~ | 0.78 |
| Health care facility[c, i] | | |
| In an exam/treatment room | ~~1.40~~ | 1.33 |
| In an imaging room | ~~0.94~~ | 0.94 |
| In a medical supply room | ~~0.62~~ | 0.56 |
| In a nursery | ~~0.92~~ | 0.87 |
| In a nurse's station | ~~1.17~~ | 1.07 |
| In an operating room | ~~2.26~~ | 2.26 |
| In a physical therapy room | ~~0.91~~ | 0.82 |
| In a recovery room | ~~1.25~~ | 1.18 |
| In a telemedicine room | | 1.44 |
| Library | | |
| In a reading area[((n)) i] | ~~0.96~~ | 0.82 |
| In the stacks | ~~1.10~~ | 1.12 |
| Manufacturing facility | | |
| In a detailed manufacturing area | ~~0.80~~ | 0.71 |
| In an equipment room | ~~0.76~~ | 0.69 |
| In an extra high bay area (greater than 50-foot floor-to-ceiling height) | ~~1.42~~ | 1.29 |
| In a high bay area (25 - 50-foot floor-to-ceiling height) | ~~1.24~~ | 1.18 |
| In a low bay (< 25-foot floor-to-ceiling height) | ~~0.86~~ | 0.81 |
| Museum | | |
| In a general exhibition area[i] | ~~0.31~~ | 0.29 |
| In a restoration room | ~~1.10~~ | 1.18 |
| Performing arts theater dressing/fitting room | ~~0.41~~ | 0.37 |
| Post office - Sorting area | ~~0.76~~ | 0.67 |
| Religious buildings | | |
| In a fellowship hall[((n)) i] | ~~0.54~~ | 0.48 |
| In a worship/pulpit/choir area[((n)) i] | ~~0.85~~ | 0.71 |
| Retail facilities | | |
| In a dressing/fitting room | ~~0.51~~ | 0.43 |
| Hair salon | | 0.62 |
| Nail salon | | 0.71 |
| In a mall concourse | ~~0.82~~ | 0.54 |
| Massage space | | 0.77 |

**Table C405.4.2(2)—continued**
**Interior Lighting Power Allowances—Space-by-Space Method**

| Common Space-by-Space Types[a] | ((~~LPD (w/ft$^2$)~~) | LPD (w/ft$^2$) |
|---|---|---|
| Sports arena - Playing area | | |
| For a Class 1 facility((~~i~~)) d | ~~2.94~~ | 2.72 |
| For a Class 2 facility((~~j~~)) e | ~~2.01~~ | 1.88 |
| For a Class 3 facility((~~k~~)) f | ~~1.30~~ | 1.23 |
| For a Class 4 facility((~~l~~)) g | ~~0.86~~ | 0.81 |
| Sports arena - Pools | | |
| For a Class 1 facility[i] | | 2.09 |
| For a Class 2 facility[j] | | 1.40 |
| For a Class 3 facility[k] | | 0.94 |
| For a Class 4 facility[l] | | 0.56 |
| Transportation | | |
| Airport Hangar | | 1.29 |
| In a baggage/carousel area | ~~0.39~~ | 0.27 |
| In an airport concourse | ~~0.25~~ | 0.47 |
| At a terminal ticket counter((~~n~~)) i | ~~0.51~~ | 0.38 |
| Passenger loading area | | 0.67 |
| Warehouse - Storage area | | |
| For medium to bulky palletized items | ~~0.33~~ | 0.31 |
| For smaller, hand-carried items | ~~0.69~~ | 0.66 |

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m$^2$.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.
b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.
c. Additional lighting power allowance of 0.2 watts per square foot for the purpose of highlighting art or exhibits. This additional power shall be permitted only where the specified lighting is installed in addition to and controlled separately from general lighting in accordance with Section C405.2.6. This additional power shall be used only for the specified luminaires, shall not be used for any other purpose, and shall not be added to any other space or the interior power allowance.
d. Reserved.
e. Reserved.
f. Reserved.
g. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.
h. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.
i. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.
j. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.
k. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.
l. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.
m. For classrooms, additional lighting power allowance of 4.50 W/ lineal foot of white or chalk boards for directional lighting dedicated to white or chalk boards.
n. Additional lighting power allowance of 0.15 W/ft$^2$ for ornamental lighting. Qualifying ornamental lighting includes luminaires that are specifically used in a decorative manner. This additional power shall be permitted only where the specified lighting is installed in addition to and controlled separately from display or general lighting in accordance with Section C405.2.6. This additional power shall be used only for the specified luminaires and it shall not be added to any other space or the interior power allowance.
o. For scientific laboratories, additional lighting power allowance of 0.35 Watts per square foot for specialized task work - lighting that provides for small-scale, cognitive or fast performance visual tasks; lighting required for operating specialized equipment associated with pharmaceutical/laboratorial activities.
p. For offices, additional lighting power allowance of 0.20 W/square foot for portable lighting, which includes under shelf or furniture-mounted supplemental task lighting qualifies when controlled by a time clock or an occupancy sensor
q. Where a space is designated as unfinished, neither the area nor the lighting power in the space shall be calculated as part of the LPA.
r. For corridors, additional lighting power allowance of 0.25 W/square foot for display lighting and decorative lighting is permitted where provided for aesthetic purposes. Decorative lighting fixtures in corridors are also permitted to provide general lighting.

**C405.5 Exterior lighting power requirements.** The total connected exterior lighting power calculated in accordance with Section C405.5.2 shall not be greater than the exterior lighting power allowance calculated in accordance with Section C405.5.3.

**C405.5.1 Exterior building grounds lighting.** All exterior building grounds luminaires that operate at greater than 25 watts shall have a minimum efficacy of 100 lumens per watt.

**EXCEPTIONS:**

1. Luminaires controlled by a motion sensor.
2. Luminaires that qualify for one of the exceptions under Section C405.5.2.

**C405.5.2 Total connected exterior building lighting power.** The total exterior connected lighting power shall be the total maximum rated wattage of all exterior lighting that is powered through the energy service for the building.

**EXCEPTION:** Lighting used for the following applications shall not be included:

1. Lighting approved because of safety considerations;
2. Emergency lighting automatically off during normal business operation;
3. Exit signs;
4. Specialized signal, directional and marker lighting associated with transportation;
5. Advertising signage or directional signage;
6. Integral to equipment or instrumentation and is installed by its manufacturer;
7. Theatrical purposes, including performance, stage, film production and video production;
8. Athletic playing areas;
9. Temporary lighting;
10. Industrial production, material handling, transportation sites and associated storage areas;
11. Theme elements in theme/amusement parks;
12. Lighting integrated within or used to highlight features of art, public monuments and the national flag;
13. Lighting for water features and swimming pools; and
14. Lighting that is controlled from within dwelling units, where the lighting complies with Section R404.1.

**C405.5.3 Exterior lighting power allowance.** The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to Table C405.5.3(1), unless otherwise specified by the code official.
2. For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from Table C405.5.3(2). For area types not listed, select the area type that most closely represents the proposed use of the area. Covered parking garage lighting is not considered exterior lighting for the purposes of this calculation.
3. Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.3(2) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.3(2), plus the watts from each area type.

**C405.5.3.1 Additional exterior lighting power.** Additional exterior lighting power allowances are available for the specific lighting applications listed in Table C405.5.3(3). These additional power allowances shall be used only for the luminaires serving these applications and shall not be used to increase any other lighting power allowance.

**TABLE C405.5.3(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 us areas |
| 3 | All other areas no classified as lighting zone 1, 2 or 4 |
| ((4)) Not used | ((~~High activity commercial districts in major metropolitan areas as designated by the local land us planning authority~~)) |

**TABLE C405.5.3(2)**
**LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

| | Lighting Zones | | | |
|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | ((~~Zone 4~~ |
| Base Site Allowance | 160 W | 280 W | 400 W | ~~560 W~~ |
| **Uncovered Parking Areas** | | | | |
| Parking areas and drives | 0.015 W/ft$^2$ | 0.026 W/ft$^2$ | 0.037 W/ft$^2$ | ~~0.052 W/ft$^2$~~ |
| **Building Grounds** | | | | |
| Walkways and ramps less than 10 feet wide | 0.04 W/ft$^2$ | 0.07 W/ft$^2$ | 0.10 W/ft$^2$ | ~~0.14 W/ft$^2$~~ |
| Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas | 0.04 W/ft$^2$ | 0.07 W/ft$^2$ | 0.10 W/ft$^2$ | ~~0.14 W/ft$^2$~~ |
| Dining areas | 0.156 W/ft$^2$ | 0.273 W/ft$^2$ | 0.390 W/ft$^2$ | ~~0.546 W/ft$^2$~~ |
| Stairways | Exempt | Exempt | Exempt | ~~Exempt~~ |
| Pedestrian tunnels | 0.063 W/ft$^2$ | 0.110 W/ft$^2$ | 0.157 W/ft$^2$ | ~~0.220 W/ft$^2$~~ |
| Landscaping | 0.014 W/ft$^2$ | 0.025 W/ft$^2$ | 0.036 W/ft$^2$ | ~~0.050 W/ft$^2$~~ |
| **Building Entrances and Exits** | | | | |
| Pedestrian and vehicular entrances and exits | 5.6 W/linear foot of opening | 9.8 W/linear foot of opening | 14.0 W/linear foot of opening | ~~19.6 W/linear foot of opening~~ |
| Entry canopies | 0.072 W/ft$^2$ | 0.126 W/ft$^2$ | 0.180 W/ft$^2$ | ~~0.252 W/ft$^2$~~ |
| Loading docks | 0.104 W/ft$^2$ | 0.182 W/ft$^2$ | 0.260 W/ft$^2$ | ~~0.364 W/ft$^2$~~ |
| **Sales Canopies** | | | | |
| Free standing and attached | 0.20 W/ft$^2$ | 0.35 W/ft$^2$ | 0.50 W/ft$^2$ | ~~0.70 W/ft$^2$~~ |
| **Outdoor Sales** | | | | |
| Open areas (including vehicle sales lots) | 0.072 W/ft$^2$ | 0.126 W/ft$^2$ | 0.180 W/ft$^2$ | ~~0.252 W/ft$^2$~~ |
| Street frontage for vehicle sales lots in addition to "open area" allowance | No Allowance | 7 W/linear foot | 10.3 W/linear foot | ~~14.4 W/linear foot~~)) |

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W per m$^2$

**TABLE C405.5.3(3)**
**INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS**

| | Lighting Zones | | | |
|---|---|---|---|---|
| | Zone 1 | Zone 2 | Zone 3 | ((~~Zone 4~~ |
| Building façade | No allowance | 0.075 W/ft$^2$ of gross above-grade wall area | 0.113 W/ft$^2$ of gross above-grade wall area | ~~0.150 W/ft$^2$ of gross above-grade wall area~~ |
| Automated teller machines (ATM) and night depositories | 80 W per location plus 25 per additional ATM | 80 W per location plus 25 per additional ATM | 80 W per location plus 25 per additional ATM | ~~80 W per location plus 25 per additional ATM~~ |
| Uncovered entrances and gatehouse inspection stations at guarded facilities | 0.144 W/ft$^2$ | 0.252 W/ft$^2$ | 0.360 W/ft$^2$ | ~~0.504 W/ft$^2$~~ |
| Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles | 0.104 W/ft$^2$ | 0.182 W/ft$^2$ | 0.260 W/ft$^2$ | ~~0.364 W/ft$^2$~~ |
| Drive-up windows/doors | 53 W per drive through | 92 W per drive through | 132 W per drive through | ~~185 W per drive through~~ |
| Parking near 24-hour retail entrances | 80 W per main entry | 140 W per main entry | 200 W per main entry | ~~280 W per main entry~~)) |

**C405.5.3.1 Additional exterior lighting power.** Any increase in the exterior lighting power allowance is limited to the specific lighting applications indicated in Table C405.5.3(3). The additional power shall be used only for the luminaires that are serving these applications and shall not be used for any other purpose.

**C405.5.4 Gas lighting.** Gas-fired lighting appliances shall not be equipped with continuously burning pilot ignition systems.

**C405.5.5 Full cutoff luminaires.** For open parking and outdoor areas and roadways, luminaires mounted more than 15 feet above the ground shall have a luminaire light distribution in which zero candela intensity occurs at an angle of 90 degrees above nadir, and all greater angles from nadir.

**C405.7.1 Electric receptacles at dwelling unit gas appliances.** Where *dwelling unit* appliances are served by natural gas, an electrical receptacle or junction box and circuit shall be provided at each gas appliance with sufficient capacity to serve a future electric appliance in the same location. The receptacles and circuits shall be included in the electrical service load calculation and shall meet the requirements of items 1 through 3 below. The receptacle or junction box for each gas appliance shall be located within 12 inches of the appliance and without obstructions between the appliance and the outlet. An electric receptacle is not required for a decorative gas fireplace.

1. Each gas range, cooktop, or oven, or combination appliance, location shall be served by a dedicated 240/208-volt, 40-amp receptacle connected to the *dwelling unit* electric panel with a 3-conductor branch circuit complying with 210.19(A)(3) of the NEC as adopted by Washington state and a minimum included load of 9600 VA for 240-volt systems or 8000 VA for 208-volt systems.
2. Each gas clothes dryer location shall be served by a dedicated 240/208-volt, 30-amp receptacle connected to the *dwelling unit* electric panel with a 3-conductor branch circuit and a minimum included load of 5000 VA.
3. The location of each gas domestic water heater installed within a *dwelling unit* shall be served by a dedicated 240/208-volt, 30-amp junction box connected to the *dwelling unit* electrical panel with a 3-conductor branch circuit and a minimum included load of 4500 VA.

**C405.8 Electric motor efficiency.** All electric motors, fractional or otherwise, shall meet the minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with DOE 10 CFR. The efficiency shall be verified through certification under an approved certification program, or, where no certification program exists, the equipment efficiency rating shall be supported by data furnished by the motor manufacturer.

**EXCEPTION:** The standards in this section shall not apply to the following exempt electric motors.

1. Air-over electric motors.
2. Component sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.
6. Mechanical ventilation system types with an input power less than 746 watts that comply with the requirements of Section C403.8.4.

Fractional hp fan motors that are 1/12 hp or greater and less than 1 hp (based on output power) which are not covered by Tables C405.8(3) and C405.8(4) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustment for airflow balancing in lieu of a varying motor speed.

**EXCEPTIONS:**

1. Motors that are an integral part of specialized process equipment.
2. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.
3. Motors used as a component of the equipment meeting the minimum efficiency requirements of Section C403.3.2 and Tables C403.3.2(1) through C403.3.2(16), provided that the motor input is included when determining the equipment efficiency.
4. Motors in the airstream within fan coils and terminal units that operate only when providing heating to the space served.
5. ((~~Fan motors that are not covered by Tables C405.8(1) through C405.8(4) and are used to power heat recovery ventilators, energy recovery ventilators, or local exhaust fans in Group R subject to the efficacy requirements of Section C403.8.4.~~)) Mechanical ventilation system types with an input power less than 746 watts that comply with the requirements of Section C403.8.4.
6. Domestic clothes dryer booster fans, range hood exhaust fans, and domestic range booster fans that operate intermittently.
7. Radon and contaminated soil exhaust fans.

((~~8. Group R heat recovery ventilator and energy recovery ventilator fans that are less than 400 cfm.~~))

**C405.9.2 Escalators and moving walks.** Escalators and moving walks shall comply with ASME A17.1/CSA B44 and shall have automatic controls that reduce speed as permitted speed in accordance with ASME A17.1/CSA B44 and applicable local code when not conveying passengers.

**EXCEPTION:** A variable voltage drive system that reduces operating voltage in response to light loading conditions is allowed to be provided in lieu of the variable speed function.

**C405.9.2.1 Energy recovery.** Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction.

**C405.10 Automatic receptacle control.** The following shall have automatic receptacle control complying with Section C405.10.1:

1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms and individual workstations, including those installed in modular partitions and module office workstation systems.
2. At least 50 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

**C405.10.1 Automatic receptacle control function.** Automatic receptacle controls shall comply with the following:

1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.
2. One of the following methods shall be used to provide control:
   2.1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 square feet (464.5 $m^2$) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 feet (1524 m).
   2.2. An occupant sensor control that shall turn off receptacles within 20 minutes of all occupants leaving a space.
   2.3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the local area is unoccupied.
3. All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.
4. Plug-in devices shall not ((~~comply~~)) be permitted to substitute for controlled receptacles.

**EXCEPTION:** Automatic receptacle controls are not required for the following:

1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.
3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.

**SDCI Informative Note:** The requirements of this section also apply to rooms and spaces that have substantially similar functions to those listed even when they are labeled with different names. For example, an area designed for office functions that is labeled "work room," or a room used as a classroom that is labeled "student learning" would each be required to provide *controlled receptacles*.

**C405.11 Voltage drop.** The total voltage drop across the combination of customer-owned service conductors, feeder conductors and branch circuit conductors shall not exceed five percent.

**C405.12 Alternating current-output uninterruptible power supplies (AC-output UPS).** *AC-output UPS* systems serving a *computer room* shall meet or exceed the calculation and testing requirements identified in ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) - Eligibility Criteria Version 2.0.

**EXCEPTION:** AC-output UPC that utilizes standardized NEMA-1-15P or NEMA 5-15P input plug, as specified in ANSI/NEMA WD 6.

**C405.13 Commissioning.** Controlled receptacles and lighting systems shall be commissioned in accordance with Section C408.

**C405.14 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.

**C405.14.1 Electric power at gas-fired commercial cooking appliances.** Where gas-fired commercial cooking appliances in commercial kitchens are provided in a building permitted under this 2021 edition of the Seattle Energy Code, an electrical panel shall be provided within or adjacent to each space in which commercial cooking appliances are located, sized to serve future electric appliances to replace all gas-fired appliances in the space with a minimum capacity of 293 VA per kBTUH of gas appliance input capacity. The main electric service panel for the building shall be wired to and sized to accommodate all such commercial cooking appliance panels. Permit documents shall include a table listing each gas-fired commercial cooking appliance as well as an equivalent electric appliance providing the same or greater cooking capacity, and the total amperage required for the commercial kitchen electrical panel. This information shall be provided in both the mechanical and the electrical permit documents.

**EXCEPTION:** This requirement does not apply to gas-fired commercial cooking appliances installed in buildings originally permitted in compliance with an earlier edition of the Seattle Energy Code, if the building's main service panel lacks sufficient capacity to provide power for equivalent electric versions of all the gas-fired commercial cooking appliances identified in the permit application.

## SECTION C406
## ADDITIONAL ENERGY EFFICIENCY AND LOAD MANAGEMENT CREDITS

**C406.1 Additional energy efficiency and load management measures credit requirements.** The project as defined in the building permit shall meet the following requirements as applicable:

1. New buildings, changes in *space conditioning category*, change of occupancy group, and building additions in accordance with Chapter 5 shall comply with sufficient measures from Section C406.2 so as to achieve the minimum number of required efficiency credits shown in Table C406.1.
2. New buildings greater than 5000 gross square feet of floor area shall comply with sufficient measures from Section C406.3 so as to achieve the minimum number of required load management credits shown in Table C406.1.
3. Tenant spaces shall comply in accordance with Section C406.1.1.

**SDCI Informative Note:** In this section "tenant space" means any conditioned area within a new building that is constructed for first occupancy under a separate permit from the shell and core permits.

4. Projects using discrete area credit weighting shall comply in accordance with Section C406.1.2.

**EXCEPTIONS:**

1. Low energy spaces in accordance with Section C402.1.1.1, equipment buildings in accordance with Section C402.1.2, unconditioned spaces, open parking garages, and enclosed parking garages that comply with sufficient measures from Table C406.2(1) to achieve a minimum of 50 percent of the efficiency credits required for new construction. Such projects shall be exempt from the load management requirements in Table C406.1.
2. Building additions that have less than 1,000 square feet of *conditioned floor area* that comply with sufficient measures from Table C406.2(1) to achieve a minimum of 50 percent of the efficiency credits required for additions.
3. Warehouses are exempt from the load management credit requirements in Table C406.1.

**Table C406.1**
**Energy Measure Credit Requirements**

| Required Credits for Projects | Section | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|
| | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| New building energy efficiency credit requirement | C406.2 | 54 | 41 | 42 | 48 | 74 | 49 |
| Building additions energy efficiency credit requirement | C406.2 | 27 | 20 | 21 | 23 | 36 | 21 |
| New building load management credit requirement | C406.3 | 12 | 15 | 27 | 15 | 13 | 26 |

**C406.1.1 Tenant spaces.** An initial tenant improvement shall comply with sufficient measures from Table C406.2(1) to achieve a minimum of efficiency credits required in Table C406.1 and are not required to achieve any load management credits. In projects with multiple tenant spaces, each tenant space is permitted to apply for different measures provided the weighted average of all areas in the project ((~~comply~~)) complies with the overall efficiency credit requirement in Table C406.1. Whole building or addition energy credits shall be allocated to tenant spaces in accordance with Sections C406.1.1.1 and C406.1.1.2. This provision only applies to the initial buildout of a tenant space.

**EXCEPTIONS:**

1. An initial tenant improvement where the core and shell building complied via Section C407 in 2018 or later edition of the ((~~Washington State~~)) Seattle Energy Code.
2. Previously occupied tenant spaces in existing buildings that comply with this code in accordance with Section C501.

**C406.1.1.1 Applicable envelope, renewable and elevator energy credits.** Where an entire building or building addition complies with Section ((~~C406.2.4, C406.2.9, C406.2.10, or C406.2.14~~)) C406.2.5, C406.2.12, C406.2.13, or C406.2.18, under an initial tenant improvement permit, tenant spaces within the building qualify for the number of credits assigned to the occupancy group of the tenant space in accordance with Table C406.2(1). Where prior energy credits were achieved under the 2018 Washington State Energy Code, they shall be multiplied by 6 for applicability to this code.

**C406.1.1.2 Applicable HVAC and service water heating credits.** Where HVAC and service water heating systems and services are installed and comply with Section ((~~C406.2.4,~~)) C406.2.2, C406.2.8, or C406.2.9, ((~~C406.2.10, or C406.2.14~~)) under an initial tenant improvement permit, those systems and services shall be considered a part of the tenant space. Tenant spaces qualify for the credits assigned to the occupancy group of the tenant space in accordance with Table C406.2(1) if the tenant space includes the distribution system and equipment that the central HVAC systems or service water heating systems were designed to support.

**C406.1.2 Discrete area-weighted project compliance.** Discrete building areas are permitted to select different packages of measures provided that the whole project complies with both the energy and load management credit requirements. Compliance shall be determined as follows:

1. Required project credits shall be prorated on an area-weighted basis for each occupancy group by multiplying the occupancy group floor area by the number of credits required, and then dividing this value by the total area of all the occupancy groups combined. Where one occupancy group is less than 10 percent of the floor area of the project, use the primary occupancy group for those credits.
2. Occupancies are permitted to be subdivided into discrete areas, with required and achieved credits for each area prorated on an area-weighted basis as required for the occupancy group.
3. Where envelope or lighting power credits in Section C406.2.3.1, C406.2.3.2, or C406.2.3.12 are applied, the lighting power or envelope UA percentage reduction shall be calculated for the project as a whole to determine achieved credits.
4. Determine total project credits achieved by area-weighting the achieved credits by occupancy group in the same manner as for required project credits.
5. A project complies when the achieved number of area-weighted energy and load management credits are equal to or greater than the required area-weighted number of credits.

**C406.2 Additional energy efficiency credit measures.** Each energy efficiency credit measure used to meet credit requirements for the project shall include efficiency that is greater than the energy efficiency required for the building type and configuration requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.14 shall achieve the credits listed for the measure and occupancy group in Table C406.2(1) or Table C406.2(2) or where calculations required by Sections C406.2.1 through C406.2.14 create or modify the table credits, the credits achieved shall be based upon the section calculations. Projects that ((~~chose~~)) choose to comply with either fossil fuel pathway in Section C406.1.3 shall use Table C406.2(2) to achieve credits.

For mixed fuel space heating systems, the number of space heating energy efficiency credits available for measures with a prorating flag "Heat" are calculated using the following equation:

$$C_{SH} = CHP_{SH} \times B/C + CFF_{SH} \times (1 - B/C)$$

Where:

$C_{SH}$ = Blended credits for mixed fuel systems.
$CHP_{SH}$ = Credits available in Table C406.2(1).
$CFF_{SH}$ = Credits available in Table C406.2(2).

B = Installed space heating capacity in kBTU/h of space heating appliances that comply with Section C403.1.4 or any of the exceptions to Section C403.1.4.

C = Total installed space heating capacity in kBTU/h of all space heating appliances.

For mixed fuel service water heating systems, the number of service water heating energy efficiency credits available for measures with a prorating flag "SWH" are calculated using the following equation:

$$C_{WH} = CHP_{WH} \times B/C + CFF_{WH} \times (1 - B/C)$$

Where:

$C_{WH}$ = Blended credits for mixed fuel systems.

$CHP_{WH}$ = Credits available in Table C406.2(1).

$CFF_{WH}$ = Credits available in Table C406.2(2).

B = Installed service water heating capacity in kBTU/h of service water heating appliances that comply with ((~~any of the~~)) Section C404.2.1 or exceptions 1, 2, 5, 7, or 8 to Section C404.2.1, but not including the supplemental capacity permitted by Section C404.2.1.4, and without utilizing Section C401.3.

C = Total installed service water heating capacity in kBTU/h of all service water heating appliances, but not including the supplemental capacity permitted by Section C404.2.1.4.

**Table C406.2(1)**
**Efficiency Measure Credits**

| Measure Title | Applicable Section | Prorating Flag | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| 1. Dwelling unit HVAC control | ((~~C406.2.2~~)) C406.2.1 | Heat | NA | 7 | NA | NA | NA | NA |
| 2. Improved HVAC TSPR[a] | C406.2.2.1 | Heat | NA | 8 | 11 | 17 | 22 | NA |
| 3. Improve cooling and fan efficiency | C406.2.2.2 | Heat | ((~~2~~)) 8 | ((~~2~~)) 5 | ((~~3~~)) 10 | ((~~4~~)) 10 | ((~~3~~)) 8 | ((~~2~~)) 8 |
| 4. Improve heating efficiency | C406.2.2.3 | Heat | ((~~2~~)) 1 | ((~~3~~)) 1 | ((~~3~~)) 1 | ((~~10~~)) 1 | ((~~16~~)) 2 | ((~~7~~)) 1 |
| 5. Improved low-carbon district energy system (10% better) | C406.2.2.4 | | 3 | 3 | 4 | 11 | 17 | 8 |
| 6. Improved low-carbon district energy system (20% better)[b] | C406.2.2.5 | | 9 | 10 | 12 | 33 | 52 | 24 |
| 7. High performance DOAS | C406.2.2.6 | Heat | 31 | 31 | 21 | 39 | 40 | 21/ (Group A: 40)[c] |
| 8. Fault detection & diagnostics (FDD) | C406.2.2.7 | Heat | 2 | 2 | 2 | 6 | 9 | 4 |
| 9. 10% reduced lighting power | C406.2.3.1 | Heat | 7 | 4 | 18 | 16 | ((~~20~~)) 36 | ((~~15~~)) 16 |
| 10. 20% reduced lighting power[d] | C406.2.3.2 | Heat | 13 | 8 | 36 | 32 | ((~~52~~)) 72 | ((~~29~~)) 32 |
| 11. Lamp efficacy improvement | C406.2.3.3 | Heat | 5 | 6 | NA | NA | NA | NA |
| 12. Residential lighting control | C406.2.4.1 | Heat | NA | 8 | NA | NA | NA | NA |
| 13. Enhanced lighting control | C406.2.4.2 | Heat | 1 | 1 | 6 | 6 | 11 | ((~~6~~)) 5 |
| 14. Renewable energy | C406.2.5 | | 7 | 12 | 13 | 13 | 10 | 11 |
| 15. Shower drain heat recovery | C406.2.6.1 | SWH | 9 | 30 | NA | 3 | NA | NA |
| 16. Service water heat recovery | C406.2.6.2 | SWH | 35 | 111 | 13 | 14 | (Grocery) 41[e] | NA |
| ((~~17. Heat pump water heating~~ | ~~C406.2.6.3~~ | ~~SWH~~ | ~~81~~ | ~~261~~ | ~~17~~ | ~~33~~ | ~~(Grocery) 95~~[e] | ~~(A-2) 95~~[f])) |
| 17. High efficiency service water heating, gas-fired | C406.2.6.4 | SWH | NA | NA | NA | NA | NA | NA |
| 18. Heat trace system | C406.2.7.1 | SWH | 6 | 13 | 4 | 1 | NA | 6 |
| 19. Point of use water heater | C406.2.7.2 | SWH | NA | NA | 19 | 5 | NA | NA |
| 20. Service hot water distribution right sizing | C406.2.8 | SWH | ((~~13~~)) NA | ((~~42~~)) 10 | NA | NA | NA | NA |
| 21. High performance service hot water temperature maintenance system | C406.2.9 | SWH | 6 | 13 | 4 | 1 | NA | 6 |

**Table C406.2(1)—continued**
**Efficiency Measure Credits**

| Measure Title | Applicable Section | Prorating Flag | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| ((~~22. High efficiency service hot water circulation system~~ | ~~C406.2.10~~ | ~~SWH~~ | ~~3~~ | ~~6~~ | ~~2~~ | ~~1~~ | ~~NA~~ | ~~4~~)) |
| 23. Low flow residential showerheads | C406.2.11 | SWH | 3 | 3 | NA | NA | NA | NA |
| 24. Enhanced envelope performance[g] | C406.2.12 | Heat | 24 | 20 | 13 | 5 | 19 | ((~~14~~)) 16 |
| 25. Base reduced air leakage[g] | C406.2.13.2 | | 29 | 24 | 6 | 3 | 9 | ((~~11~~)) 14 |
| 26. Enhanced reduced air leakage[g] | C406.2.13.3 | Heat | 53 | 44 | 11 | 5 | 16 | ((~~20~~)) 26 |
| ((~~27. Enhanced commercial kitchen equipment~~ | ~~C406.2.14~~ | ~~Heat~~ | ~~30[h]~~ | ~~18[h]~~ | ~~18[h]~~ | ~~30[h]~~ | ~~30[h]~~ | ~~31[h]~~)) |
| 28. Enhanced residential kitchen equipment | C406.2.15 | Heat | 12 | 19 | NA | NA | NA | NA |
| 29. Enhanced residential laundry equipment | C406.2.16 | Heat | NA | 6 | NA | NA | NA | NA |
| 30. Heat pump clothes dryers | C406.2.17 | Heat | 6 | 6 | NA | NA | NA | NA |
| 31. Efficient elevator equipment | C406.2.18 | Heat | 3 | 5 | 5 | 5 | 4 | 4 |

a. Projects using Item 2 shall not use Items ((~~3 through 5~~)) 3, 4, or 7.
b. Projects using C406.2.2.5 shall not use C406.2.2.4.
c. For C406.2.2.6, occupancy Group A achieves 40 credits while other occupancy groups within the "all other" category achieve 21 credits.
d. Projects using C406.2.3.2 shall not use C406.2.3.1.
e. Service water heat recovery and heat pump water heating are available in Group M only for grocery stores larger than 10,000 $ft^2$. Large mixed retail with full grocery and butcher sections shall achieve half the credits. This credit is not available where refrigeration recovery to heat service hot water is used to meet the requirements of Section C403.9.2.3.
f. Heat pump water heating efficiency credits are available in the "all other" category only for Group A-2.
g. Buildings or building areas that are exempt from the thermal envelope requirements in accordance with Sections C402.1.1 and C402.1.2, do not qualify for this package.
((~~h. Additional energy efficiency credits, up to the maximum shown in Table C406.2(2), shall be calculated according to Section C406.2.14.~~))

**Table C406.2(2)**
**Efficiency Measure Credits for use with Fossil Fuel Compliance Path**

| Measure Title | Applicable Section | Prorating Flag | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| 1. Dwelling unit HVAC control | C406.2.2 | Heat | NA | 8 | NA | NA | NA | NA |
| 2. Improved HVAC TSPR[a] | C406.2.2.1 | Heat | NA | 9 | 12 | 19 | 24 | NA |
| 3. Improve cooling and fan efficiency | C406.2.2.2 | Heat | 12 | 8 | 14 | 8 | 10 | 10 |
| 4. Improve heating efficiency | C406.2.2.3 | Heat | 2 | 3 | 3 | 11 | 18 | 8 |
| 5. Improved low-carbon district energy system (10% better) | C406.2.2.4 | | 3 | 3 | 4 | 12 | 19 | 9 |
| 6. Improved low-carbon district energy system (20% better)[b] | C406.2.2.5 | | 10 | 11 | 13 | 36 | 57 | 26 |
| 7. High performance DOAS | C406.2.2.6 | Heat | 34 | 34 | 23 | 43 | 44 | 23/ (A) 40[c] |
| 8. Fault detection & diagnostics (FDD) | C406.2.2.7 | Heat | 2 | 2 | 2 | 6 | 9 | 4 |
| 9. 10% reduced lighting power | C406.2.3.1 | Heat | 7 | 4 | 18 | 16 | 20 | 15 |
| 10. 20% reduced lighting power[d] | C406.2.3.2 | Heat | 13 | 8 | 36 | 32 | 40 | 29 |
| 11. Lamp efficacy improvement | C406.2.3.3 | Heat | 5 | 6 | NA | NA | NA | NA |
| 12. Residential lighting control | C406.2.4.1 | Heat | NA | 8 | NA | NA | NA | NA |
| 13. Enhanced lighting control | C406.2.4.2 | Heat | 1 | 1 | 6 | 6 | 11 | 6 |
| 14. Renewable energy | C406.2.5 | | 7 | 12 | 13 | 13 | 10 | 11 |
| 15. Shower drain heat recovery | C406.2.6.1 | SWH | 10 | 33 | NA | 3 | NA | NA |
| 16. Service water heat recovery | C406.2.6.2 | SWH | 35 | 111 | 13 | 14 | (Grocery) 41[e] | NA |
| 17. Heat pump water heating | C406.2.6.3 | SWH | 81 | 261 | 17 | 33 | (Grocery) 95[e] | (A-2) 95[f] |
| 18 High efficiency service water heating, gas-fired | C406.2.6.4 | SWH | 59 | 65 | 6 | 11 | 18 | 32 |
| ((~~18~~)) 19. Heat trace system | C406.2.7.1 | SWH | 6 | 13 | 4 | 1 | NA | 6 |
| ((~~19~~)) 20. Point of use water heater | C406.2.7.2 | SWH | NA | NA | 19 | 5 | NA | NA |

**Table C406.2(2)—continued**
**Efficiency Measure Credits for use with Fossil Fuel Compliance Path**

| Measure Title | Applicable Section | Prorating Flag | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| ((~~20~~)) 21. Service hot water distribution right sizing | C406.2.8 | SWH | ((~~13~~)) NA | ((~~42~~)) 10 | NA | NA | NA | NA |
| ((~~21~~)) 22. High performance service hot water temperature maintenance system | C406.2.9 | SWH | 6 | 13 | 4 | 1 | NA | 6 |
| ((~~22. High efficiency service hot water circulation system~~ | ~~C406.2.10~~ | ~~SWH~~ | ~~3~~ | ~~6~~ | ~~2~~ | ~~1~~ | ~~NA~~ | 4)) |
| 23. Low flow residential showerheads | C406.2.11 | SWH | 3 | 3 | NA | NA | NA | NA |
| 24. Enhanced envelope performance[g] | C406.2.12 | Heat | 24 | 20 | 13 | 5 | 19 | 14 |
| 25. Base reduced air leakage[g] | C406.2.13.2 | | 29 | 24 | 6 | 3 | 9 | 11 |
| 26. Enhanced reduced air leakage[g] | C406.2.13.3 | Heat | 53 | 44 | 11 | 5 | 16 | 20 |
| ((~~27. Enhanced commercial kitchen equipment~~ | ~~C406.2.14~~ | ~~Heat~~ | ~~30[h]~~ | ~~18[h]~~ | ~~18[h]~~ | ~~30[h]~~ | ~~30[h]~~ | ~~31[h]~~)) |
| 28. Enhanced residential kitchen equipment | C406.2.15 | Heat | 12 | 19 | NA | NA | NA | NA |
| 29. Enhanced residential laundry equipment | C406.2.16 | Heat | NA | 6 | NA | NA | NA | NA |
| 30. Heat pump clothes dryers | C406.2.17 | Heat | 6 | 6 | NA | NA | NA | NA |
| 31. Efficient elevator equipment | C406.2.18 | Heat | 3 | 5 | 5 | 5 | 4 | 4 |

a. Projects using Item 2 shall not use Items ((~~3 through 5~~)) 3, 4, or 7.
b. Projects using C406.2.2.5 shall not use C406.2.2.4.
c. For C406.2.2.6, occupancy Group A achieves 40 credits while other occupancy groups within the "all other" category achieve 21 credits.
d. Projects using C406.2.3.2 shall not use C406.2.3.1.
e. Service water heat recovery and heat pump water heating are available in Group M only for grocery stores larger than 10,000 $ft^2$. Large mixed retail with full grocery and butcher sections shall achieve half the credits. This credit is not available where refrigeration recovery to heat service hot water is used to meet the requirements of Section C403.9.2.3.
f. Heat pump water heating efficiency credits are available in the "all other" category only for Group A-2.
g. Buildings or building areas that are exempt from the thermal envelope requirements in accordance with Sections C402.1.1 and C402.1.2, do not qualify for this package.
((~~h. Additional energy efficiency credits, up to the maximum shown in Table C406.2(2), shall be calculated according to Section C406.2.14.~~))

**C406.2.1 Dwelling unit and Group R-1 sleeping unit HVAC controls.** HVAC systems serving *dwelling units* or Group R-1 *sleeping units* shall be controlled with a programmable *thermostat* that is configured to automatically activate a setback condition of at least 5°F (3°C) for both heating and cooling. The programmable *thermostat* shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each *dwelling unit* or Group R-1 sleeping unit main entrance that initiates setback for all HVAC units in the *dwelling unit* and is clearly identified as "Heating/Cooling Master Setback."
2. Occupancy sensors in each room of the *dwelling unit* or Group R-1 sleeping unit combined with a door switch to initiate setback for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately following a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. An advanced learning thermostat that senses occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic sensing connected to the *dwelling unit* occupants' cell phones and initiates the setback condition when all occupants are away from the building.

**C406.2.2 More efficient HVAC system performance.** All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to the minimum efficiency requirements listed in the tables in Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal efficiencies including SEER, EER/IEER, IPLV or AFUE. Equipment that is larger than the maximum capacity range indicated in the tables in Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity. This credit shall not be utilized for low energy or semi-heated *space conditioning categories*. No HVAC systems incorporating fossil fuel-fired equipment, or heat from district energy systems that are primarily heated by fossil fuel combustion, are permitted to utilize this credit unless the Section C401.3 fossil fuel compliance path is utilized for energy code compliance.

Where:

$AMLC_{DES}$ = As-designed annualized mechanical load component calculated in accordance with ASHRAE 90.4 Section 6.5.

$AMLC_{MAX}$ = Maximum annualized mechanical load component from ASHRAE 90.4 Table 6.5.

**C406.2.2.2.3 Minimum fan efficiency.** Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.

**C406.2.2.3 More efficient HVAC equipment heating performance.** No less than 90 percent of the total HVAC capacity serving the total *conditioned floor area* of the entire building, building addition or tenant space in accordance with Section C406.1.1 shall comply with Sections C406.2.2.3.1 through C406.2.2.3.2.

**C406.2.2.3.1 HVAC system selection.** Equipment installed shall be types that are listed in the tables in Section C403.3.2. Electric resistance heating shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating. No HVAC systems incorporating fossil fuel-fired equipment, or heat from district energy systems that are primarily heated by fossil fuel combustion, are permitted to utilize this credit unless the Section C401.3 fossil fuel compliance path is utilized for energy code compliance.

**C406.2.2.3.2 Heating equipment efficiency.** Equipment shall exceed the minimum heating efficiency requirements of the tables in Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-16, rounded to the nearest whole number.

$$EEC_{HEH} = EEC_5 \times \left[1 + \frac{HEI - 0.05}{0.05}\right] \quad \textbf{(Equation 4-16)}$$

Where:

$EEC_{HEH}$ = Energy efficiency credits for heating efficiency improvement.

$EEC_5$ = Section C406.2.2.2 credits from Table C406.2(1).

HEI = The lesser of the improvement above minimum heating efficiency requirements or 20 percent (0.20). Where heating efficiency varies by system, use the capacity weighted average percentage for all heating equipment combined. For metrics that increase as efficiency increases, HEI shall be calculated as follows:

$$HEI = \frac{HM_{DES}}{HM_{MIN}} - 1$$

Where:

$HM_{DES}$ = Design heating efficiency metric, part-load or annualized where available.

$HM_{MIN}$ = Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2.

**EXCEPTION:** In low energy spaces complying with Section C402.1.1 and *semi-heated spaces* complying with Section C402.1.1.2, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall achieve credits for $EEC_5$.

**C406.2.2.4 Improved low-carbon district energy systems (10 percent better).** Not less than 90 percent of the annual service hot water and space heating load, or not less than 90 percent of the annual service hot water, space heating, and space cooling load shall meet the criteria of Section C406.2.2.4.1 or C406.2.2.4.2.

Documentation for the low-carbon district system that is operational prior to the final inspection shall be provided to demonstrate that the definition as modified in Section C406.2.2.4.1 or C406.2.2.4.2 of *low-carbon district energy exchange system* is satisfied.

**C406.2.2.4.1 Improved low-carbon district energy exchange systems (10 percent better).** Low-carbon district energy exchange systems must demonstrate the following:

1. Forty-five percent of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or renewable energy resources; and
2. No more than 25 percent of the annual heat input to the system comes from fossil fuel or electric-resistance sources.

**C406.2.2.4.2 Improved low-carbon district energy heating and cooling or heating only systems (10 percent better).** Distribution losses must be accounted for and may not exceed 5 percent of the annual load delivered to buildings served by the system. *Low-carbon district energy heating and cooling or heating only systems* must demonstrate the following:

1. Forty-five percent of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or renewable energy resources and no more than 25 percent of the annual heat input to the system comes from fossil fuel or electric-resistance sources; or
2. No more than 10 percent of the system annual heat input to the system comes from fossil fuels or electric-resistance sources. The remaining annual heat input must be provided using heat pump technology with a minimum annual operating COP of 3.0.

**C406.2.2.5 Improved low-carbon district energy systems (20 percent better).** Not less than 90 percent of the annual service hot water and space heating load, or not less than 90 percent of the annual service hot water, space heating, and space cooling load shall meet the criteria of Section C406.2.2.5.1 or C406.2.2.5.2.

Documentation for the low-carbon district system that is operational prior to the final inspection shall be provided to demonstrate that the definition as modified in Section C406.2.2.4.1 or C406.2.2.4.2 of *low-carbon district energy exchange system* is satisfied.

**C406.2.2.5.1 Improved low-carbon district energy exchange systems (20 percent better).** Low-carbon district energy exchange systems must demonstrate the following:

1. Fifty percent of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or renewable energy resources; and
2. No more than 10 percent of the annual heat input to the system comes from fossil fuel or electric-resistance sources.

**C406.2.2.5.2 Improved low-carbon district energy heating and cooling or heating only systems (20 percent better).** Distribution losses must be accounted for and may not exceed 5 percent of the annual load delivered to buildings served by the system. *Low-carbon district energy heating and cooling or heating only systems* must demonstrate the following:

1. Fifty percent of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat, or renewable energy resources and no more than 10 percent of the annual heat input to the system comes from fossil fuel or electric-resistance sources; or
2. No more than 10 percent of the system annual heat input to the system comes from fossil fuels or electric-resistance sources. The remaining annual heat input must be provided using heat pump technology with a minimum annual operating COP of 4.0.

**C406.2.2.6 High performance dedicated outdoor air system (DOAS).** No less than 90 percent of the total conditioned floor area of the whole project, excluding floor area of unoccupied spaces that do not require ventilation as specified by the *International Mechanical Code*, shall be served by DOAS installed in accordance with Section C403.3.5 with the following adjustments:

1. Minimum heat recovery sensible effectiveness of 80 percent, calculated in accordance with Section C403.3.5.1, or C403.7.6.1 for R-2 occupancies.
2. Where design outdoor airflow is greater than 500 cfm (250 L/s), the DOAS shall be equipped with an economizer bypass, damper control, or wheel speed control that is active between 55°F (13°C) and 75°F (24°C) outdoor air temperature and minimizes energy recovery or maintains an appropriate DOAS leaving air temperature when the building is generally in cooling, based either on outdoor air temperature or a DDC zone-based cooling system reset.
3. DOAS total combined fan power shall comply with the fan power limits in Table C403.8.4 where applicable and shall be less than either:
   3.1. 0.769 W/cfm (1.55 W/L/s) when calculated in accordance with Section C403.3.5.2.
   3.2. Eighty percent of fan power allowance for a constant volume system when calculated in accordance with Section ((~~C406.8.1~~)) C403.8.1.

This option is not available to areas served by systems utilizing Section C403.2.2.1 exception 5. No HVAC systems incorporating fossil fuel-fired equipment, or heat from district energy systems that are primarily heated by fossil fuel

combustion, are permitted to utilize this credit unless the Section C401.3 fossil fuel compliance path is utilized for energy code compliance.

**C406.2.2.7 Fault detection and diagnostics system.** A project not required to comply with Section C403.2.3 or C403.6.10(16) shall achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

**C406.2.3 Reduced lighting power.** Interior lighting within the whole project, consisting of a whole building, building area, occupancy type, building addition, or tenant space, shall achieve credits by complying with Section C406.2.3.1 or C406.2.3.2. In Group R-1 and Group R-2 occupancies, dwelling and sleeping units shall comply with Section C406.2.3.3 and all other areas shall comply with section C406.2.3.1 or C406.2.3.2. Credits apply to the whole Group R-1 or Group R-2 area.

**C406.2.3.1 Reduced lighting power option 1.** The total connected interior lighting power calculated in accordance with Section C405.4.1 shall be 90 percent or less of the lighting power values specified in Table C405.4.2(1) times the floor area for the building types, or 90 percent or less of the total interior lighting power allowance calculated in accordance with Section C405.4.2.

**C406.2.3.2 Reduced lighting power option 2.** The total connected interior lighting power calculated in accordance with Section C405.4.1 shall be 80 percent or less of the lighting power values specified in Table C405.4.2(1) times the floor area of the building types, or 80 percent or less of the total interior lighting power allowance calculated in accordance with Section C405.4.2.

**C406.2.3.3 Lamp efficacy.** No less than 95 percent of the permanently installed light fixtures in dwelling units and sleeping units shall be provided by lamps with a minimum efficacy of 90 lumens per watt.

**C406.2.4 Lighting controls.** For buildings with nontransient dwelling units and sleeping units, energy credits shall be achieved by installation of systems that comply with the requirements of Section C406.2.4.1. All other buildings shall achieve energy credits by complying with Section C406.2.4.2. For buildings with mixed occupancies, credits shall be prorated based on floor area.

**C406.2.4.1 Residential building lighting control.** In buildings with nontransient *dwelling units* and *sleeping units*, lighting controls shall be configured to meet the following:

1. Each *dwelling unit* or *sleeping unit* shall have a main control by the main entrance that turns off all the lights and switched receptacles in the unit. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles. The main controls shall be clearly identified as "lights master off" and "switched outlets master off."
2. Switched receptacles shall be clearly identified and all switched receptacles shall be located within 12 inches of an unswitched receptacle. Each room shall have a minimum of two switched receptacles except bathrooms, kitchens, and closets.

**C406.2.4.2 Enhanced digital lighting controls.** Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project has luminaires and lighting controls that include high end trim in compliance with Section C405.2.8.3 and either *luminaire-level lighting controls* in compliance with Section C405.2.8.1 or networked lighting controls in accordance with Section C405.2.8.2. Open office areas subject to the requirements of Section C405.2.8 are not permitted to take credit for this option. Where *general lighting* in more than 50 percent of the gross floor area complies, the base credits from Table C406.2(1) shall be prorated as follows:

[Floor area with high end trim, %] × [Base energy credits for C406.2.4.2] / 50%

**C406.2.5 On-site and off-site renewable energy.** Projects installing on-site or off-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m$^2$) of building area in addition to the renewable energy capacity required elsewhere in this code shall achieve energy credits for this measure. Renewable energy systems achieving energy credits shall not be used to satisfy other requirements of this code. Off-site renewable energy systems shall comply with Sections C411.2.2 and C411.2.3. Credits shall be prorated from the table value in accordance with Equation 4-17.

$$AEC_{RRa} = AEC_b \times \frac{\sum(REF \times RR_t) - RR_r}{RR_b \times PGFA} \quad \textbf{(Equation 4-17)}$$

Where:

$AEC_{RRa}$ = Section C406.2.5 achieved energy credits for this project as calculated in accordance with Equation 4-17, limited to 50 percent of the required credits in Section C406.1.

$RR_t$ = Actual total rating of on-site and off-site renewable energy systems (W) for each type of renewable energy source in Table C411.2.1.

$RR_r$ = Rating of renewable energy systems required by Section C411.1, other sections in this code, or used to qualify for exceptions in this code (W).

$RR_b$ = 0.1 W/square foot (1.08 $W/m^2$)

PGFA = Project gross floor area, square feet ($m^2$).

$AEC_b$ = Section C406.2.5 base credits from Table C406.2(1).

REF = Renewable Energy Factor from Table C411.2.1.

*Informative Note:* On-site renewable energy may include thermal service water heating or pool water heating, in which case ratings in Btu/h can be converted to W where W = Btu/h / 3.413.

**C406.2.6 Reduced energy use in service water heating.** Buildings with service hot water heating equipment that serves the whole building, building addition or tenant space shall achieve credits through compliance with:

1. Section C406.2.6.1, C406.2.6.2, or C406.2.6.3.
2. Sections C406.2.6.1 and C406.2.6.2.
3. Sections C406.2.6.1 and C406.2.6.3.

No service water heating systems incorporating fossil fuel-fired equipment, or heat from district energy systems that are primarily heated by fossil fuel combustion, are permitted to utilize this credit.

**C406.2.6.1 Shower drain heat recovery.** Shower drain heat recovery units shall comply with Section C404.10 and preheat cold water supply to the showers. Potable waterside pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. The efficiency of drain water heat recovery units shall be no less than 54 percent in accordance with CSA B55.1. Full credits are applicable to the following building use types: Multi-family, hotel, motel, dormitory, and schools with locker room showers. Where not all showers in the project have drain heat recovery, the credit is adjusted based on the following:

[Section C406.2.6.1 table credits] × [Showers with drain recovery] / [Total number of showers]

**C406.2.6.2 Service water heating energy recovery.** Not less than 30 percent of the annual service hot water heating energy use, or not less than 70 percent of the annual service hot water heating energy use in buildings with condenser water systems subject to the requirements of Section C403.9.2.1 or qualifying for one of its exceptions, shall be provided by one or more of the following:

1. Waste heat recovery from service hot water, heat recovery chillers, building equipment, process equipment, or other *approved* system. Qualifying heat recovery must be above and beyond heat recovery required by other sections of this code.
2. On-site renewable energy water-heating systems where not used to meet other requirements or to obtain other energy credits.

**C406.2.6.3 Heat pump water heating.** Projects shall achieve credits through compliance with Section C406.2.6.3.1.

**C406.2.6.3.1 Heat pump water heater.** Credit shall be achieved where the primary heat pump service water heating system is sized to deliver no less than 100 percent of the net calculated demand for service water production during the peak demand period with entering dry bulb or wet bulb outdoor air temperature at 40°F (4°C) for air-source heat pumps, or 44°F (7°C) ground temperature for ground-source heat pumps, as calculated using the equipment manufacturer's selection criteria or another *approved* methodology. For this credit, the net calculated demand shall be the gross building demand less any portion of the demand complying with the exceptions to Section C404.2.1. Supplemental heating is permitted in accordance with Section C404.2.1, but cannot use fossil fuels. The refrigerant used in the heat pump system must have a global warming potential (GWP) no greater than 680. Heat pump water heaters shall comply with one of the following:

1. The COP rating shall be a minimum COP of 3.0 reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (16°C) or lower. For water-source equipment, the COP rating will be reported at the design leaving load water temperature with an entering load water temperature of 74°F (23°C) or lower.
2. The uniform energy factor (UEF) shall be a minimum of 3.40 rated based on U.S. Department of Energy requirements.

**C406.2.6.4 High efficiency service water heating, gas-fired.** The credit achieved shall be from Table C406.2(2) where hot water is supplied by gas-fired equipment with minimum efficiency of 0.91 UEF.

**C406.2.7 Improved service hot water temperature maintenance.** For buildings with gross floor area greater than 10,000 square feet, credit shall be achieved when hot water temperature maintenance is installed in accordance with Section C406.2.7.1 or C406.2.7.2.

**C406.2.7.1 Self-regulated heat trace system.** The credit achieved shall be from Table C406.2(1). This system shall include self-regulating electric heat cables, connection kits and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

**C406.2.7.2. Point of use water heater.** The credit achieved shall be from Table C406.2(1) where any fixtures requiring hot water shall be supplied from a localized electric source of hot water with no recirculation or heat trace and limited to 2 kW and 6 gallons of storage. The supply pipe length from the point of use water heater to the termination of the fixture supply pipe shall be no more than 20 feet.

**C406.2.8 Service hot water distribution right sizing.** To achieve this credit, where Group ((~~R-1 and R-2~~)) occupancies are served by a central service hot water system, the distribution system serving *dwelling units* ((~~, *sleeping units* and guest rooms~~)) shall be sized using Appendix M of the *Uniform Plumbing Code*.

**SDCI Informative Note:** Section C404.3.3 requires use of UPC Appendix M for determining demand load, and permits pipes to be one pipe size larger than the minimum determined using that demand load. However, this credit requires use of the minimum pipe sizes permitted by the demand load as determined using UPC Appendix M.

**C406.2.9 High performance service hot water temperature maintenance system.** Systems with multiple riser service hot water circulation systems shall use only heat pump technology for temperature maintenance. The heat pump technology shall have a minimum COP of 3.0 or UEF of 3.4. For air-source equipment, the COP rating will be reported at the design leaving heat pump water temperature with an entering dry bulb air temperature of 60°F (16°C) or lower and a relative humidity of 50 percent or lower. For water-source equipment, the COP rating will be reported at the design leaving load side water temperature with an entering source side water temperature of 74°F (23°C) or lower. The system shall comply with the requirements of Section C404.7.1.

**C406.2.10 High efficiency service hot water circulation system.** Multiple riser service hot water circulation systems shall use a variable volume circulation pump controlled to vary the pump speed based on system demand and shall include self-actuated thermostatic balancing valves to control the system flow at each riser.

**C406.2.11 Low flow showerheads for Group R-1 and R-2 occupancies.** All showerheads installed in Group R-1 and R-2 *dwelling units* or *sleeping units* shall have a maximum listed flowrate of 1.25 gallons per minute or less at 80 psi operating pressure for fixed showerheads and a maximum listed flowrate of 1.50 gallons per minute or less at 80 psi operating pressure for handheld showerheads. When a shower is served by more than one showerhead, including handheld showerheads, the combined flow rate of all showerheads and/or other shower outlets controlled by a single valve shall not exceed 1.25 gallons per minute or less for fixed or 1.5 gallons per minute or less for handheld, or the shower shall be designed to allow only one shower outlet to be in operation at a time.

**C406.2.12 Enhanced envelope performance.** The Proposed Total UA of the thermal envelope of the project shall be 15 percent lower than the Allowable Total UA determined in accordance with Section C402.1.5 and Equation 4-2.

**C406.2.13 Reduced air leakage.** Energy credits shall be achieved where measured air leakage of the total *conditioned floor area* of the whole building, fully isolated building addition or tenant space is determined in accordance with Section C402.5.1.2 and complies with the maximum leakage in either Section C406.2.13.1 or C406.2.13.2.

**C406.2.13.1 Base reduced air leakage.** Measured air leakage shall not exceed 68 percent of the maximum leakage allowed by Section C402.5.1.2.

**C406.2.13.2 Enhanced reduced air leakage.** Measured air leakage shall not exceed 33 percent of the maximum leakage allowed by Section C402.5.1.2.

((~~**C406.2.14 Enhanced commercial kitchen equipment.** For buildings or areas designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen with at least one gas or electric fryer, all fryers, dishwashers, steam cookers and ovens shall comply with all of the following:~~

~~1. Achieve the ENERGY STAR label in accordance with the specifications current as of January 1, 2022.~~

~~2. Be installed prior to the issuance of the certificate of occupancy.~~

~~3. Have the ENERGY STAR qualified model number listed on the construction documents submitted for permitting.~~

~~Energy efficiency credits for efficient commercial kitchen equipment shall be determined based on Equation 4-19, rounded to the nearest whole number.~~))

**SDCI Informative Note:** Energy Star commercial kitchen equipment is required for all commercial kitchen projects by Section C405.14.

**C406.2.15 Residential kitchen equipment.** For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where not less than 90 percent of dishwashers, refrigerators, and freezers comply with all of the following:

1. Achieve the ENERGY STAR Most Efficient label in accordance with the 2021 specifications.
2. Be installed prior to the issuance of the certificate of occupancy.

For Group R-1 where only some guestrooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

[Section C406.2.15 table credits] × [Floor area of guestrooms with kitchens] / [Total guestroom floor area]

**C406.2.16 Residential laundry appliances.** For projects with Group R-2 occupancies, energy credits shall be achieved where not less than 90 percent of clothes washers and dryers in the project meet the following requirements:

1. Each dwelling unit contains in-unit washing washer and dryer equipment that meets the following requirements:
   1.1. Achieve the ENERGY STAR Most Efficient label in accordance with the 2021 specifications.
   1.2. Be installed prior to the issuance of the certificate of occupancy.
2. Where only some dwelling units are equipped with both washers and dryers, the table credits shall be prorated as follows:

[Section C406.2.16 table credits] × [Floor area of dwelling units with laundry] / [Total dwelling unit floor area]

**C406.2.17 Heat pump clothes dryers.** Not less than 90 percent of domestic clothes dryers located in Group R-1 and R-2 of the whole project are ENERGY STAR rated heat pump dryers. Credit applies only to buildings where laundry facilities are provided either within each residential dwelling or sleeping units or grouped together in central multi-family use laundry rooms, or a mix of the two.

To claim this credit, the building permit drawings shall specify the appliance type and provide documentation of ENERGY STAR compliance. At the time of inspection, all appliances shall be installed and connected to utilities.

**C406.2.18 Efficient elevator equipment.** Qualifying elevators in the building shall be Energy Efficient Class A in accordance with ISO 25745-2, Table 7. Only buildings three or more floors above grade shall be permitted to use this credit. Credits shall be prorated based on Equation 4-18, rounded to the nearest whole credit. Projects with a compliance ratio ($CR_e$ in Equation 4-18) below 0.5 do not qualify for this credit.

$$EC_e = EC_t \times CR_e \quad \textbf{(Equation 4-18)}$$

Where:

$EC_e$ = Elevator energy credit achieved for building.
$EC_t$ = Section C406.2.18 table energy credit.
$CR_e = \frac{F_A}{F_B}$
$F_A$ = Sum of floors served by Class A elevators.
$F_B$ = Sum of floors served by all building elevators and escalators.

**C406.3 Load management credits.** Load management measures installed in the building that meet the requirements in Sections C406.3.1 through C406.3.7 shall achieve the credits listed for the occupancy group in Table C406.3 or where calculations required by Sections C406.3.1 through C406.3.7 create or modify the table credits the credits achieved will be based upon the section calculations.

Each load management measure shall require automatic controls activated by either utility demand response, utility price response signal, peak price period time control, or local building demand monitoring. Controls shall be capable of and configured to provide the required load management sequences. As used in this section, "peak period" shall be either the coincident peak building load period, the peak price period, the peak utility load period, or the peak building demand period. The following additional requirements apply to these measures:

1. Where credit is taken for C406.3.6, service water heating energy storage, the equipment shall be provided with controls that comply with ANSI/CTA 2045-B.

2. For load management measures in Sections C406.3.1 through C406.3.5:
   2.1. Where the serving utility has a real-time demand response or pricing program, an interface compliant with serving utility requirements shall be installed.
   2.2. Where the serving utility does not have a real-time demand response or pricing program, a digital input to the system to support future utility programs shall be installed and building demand monitoring shall be installed and integrated into the load management sequence.
   2.3. All equipment involved in the required load management sequence shall have controls connected to a central DDC system.

**Table C406.3**
**Load Management Measure Credits**

| Measure Title | Applicable Section | Occupancy Group | | | | | |
|---|---|---|---|---|---|---|---|
| | | Group R-1 | Group R-2 | Group B | Group E | Group M | All Other |
| 1. Lighting load management | C406.3.1 | 12 | 15 | 27 | 15 | NA | NA |
| 2. HVAC load management | C406.3.2 | 29 | 24 | 42 | 23 | 13 | 26 |
| 3. Automated shading | C406.3.3 | NA | 7 | 12 | 16 | NA | NA |
| 4. Electric energy storage | C406.3.4 | 41 | 50 | 126 | 72 | 37 | 65 |
| 5. Cooling energy storage | C406.3.5 | 13 | 10 | 14 | 19 | NA | 14 |
| 6. Service hot water energy storage | C406.3.6 | 31 | 248 | 59 | 8 | 5 | 70 |
| 7. Building thermal mass | C406.3.7 | NA | NA | 50 | 95 | 96 | 80 |

**C406.3.1 Lighting load management.** Automatic controls shall be capable of gradually reducing general lighting power with continuous dimming in 75 percent of the building area by at least 20 percent during peak demand periods. Where less than 75 percent, but at least 50 percent, of the building area lighting is controlled, the credits from Table C406.3 shall be prorated as follows:

$$\frac{[\textit{Area of building with lighting load management}, \%] \times [\textit{Table credits for } \text{C406.3.1}]}{75\%}$$

**EXCEPTION:** Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming.

**C406.3.2 HVAC load management.** Automatic controls shall:

1. Where electric cooling is used, be configured to gradually increase, over a minimum of three hours, the cooling setpoint by at least 3°F during the summer peak periods.
2. Where electric heating is used, be configured to gradually reduce, over a minimum of three hours, the heating setpoint by at least 3°F during winter peak periods.

**C406.3.3 Automated shading load management.** Where fenestration on south and west exposures exceeds 20 percent of the wall area, automatic controls shall be configured to operate movable exterior shading devices or dynamic glazing to reduce solar gain through sunlit fenestration on southern and western exposures by at least 50 percent during summer peak periods.

*Informative Note:* This credit can be met by exterior roller, movable blind or movable shutter shading devices; however, fixed overhang, screen or shutter shading will not meet the requirement. Roller shades that reject solar gain but still allow a view are allowed as long as they provide an effective 50 percent reduction in net solar gain (e.g., have a shading coefficient of less than 0.5 for the shading material itself). Interior shading devices will not meet the requirement. Electrochromatic windows that achieve 50 percent of SHGC would qualify.

**C406.3.4 Electric energy storage.** Automatic controls shall store electricity in electric storage devices during nonpeak periods and use stored energy during peak periods. Electric storage devices shall have a minimum capacity of 5 Wh/ft$^2$ (58 Wh/m$^2$) of gross building area. For greater storage capacity up to 15 Wh/ft$^2$ (160 Wh/m$^2$), credits shall be prorated as follows:

$$[\text{Installed electric storage capacity, Wh/ft}^2]/5 \times [\text{C406.3.4 credits from Table C406.3}]$$

**C406.3.5 Cooling energy storage.** Automatic controls shall be capable of activating ice or chilled water storage to reduce peak period electric demand. Credits shown in Table C406.3 are based on storage capacity of 2 ton-hours per design day ton of cooling load (2 kWh per design day kW) with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 3.5 ton-hours per design day ton (kWh per design day kW) of cooling load rounded to the nearest whole credit. The storage tank shall have no more than 1.5 percent of storage capacity standby loss per day.

**C406.3.6 Service hot water energy storage.** To achieve this credit, where service hot water is heated by electricity, automatic controls shall preheat stored service hot water before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak service hot water demand with equivalent peak storage capacity to item 1.

**C406.3.7 Building thermal mass.** To achieve this credit, the building shall have both additional passive interior mass and a night-flush control of the HVAC system.

1. Interior to the *building thermal envelope* insulation, provide 15 pounds of passive thermal mass per square foot of building floor area. Mass construction shall be in the building interior and the indoor facing portion of the exterior wall, and interior floor construction. Mass construction shall have mass surfaces in direct contact with the air in conditioned spaces with directly attached wall board or hard surface flooring allowed. Mass with carpet or furred wallboard shall not be counted toward the building mass required. For integral insulated concrete block walls complying with ASTM C90, only the mass of the interior face shall be counted toward the building mass required.
2. When summer mode is active and indoor average temperature is 5°F (3°C) or more above outdoor temperature and between 10:00 p.m. and 6:00 a.m., *automatic* night flush controls shall operate outdoor air economizers at low fan speed less than 66 percent during the unoccupied period until the average indoor air temperature falls to the occupied heating setpoint. Summer mode shall be activated when outdoor air exceeds 70°F (21°C) and continues until deactivated when outdoor air falls below 45°F (7°C). Another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating and is *approved* by the *code official*.

*Informative Note:* The simplified night flush sequence described will operate in "summer mode" below the 70°F outdoor air trigger temperature down until outdoor air of 45°F is hit when the "summer mode" is deactivated until the outdoor air temperature rises above 70°F again. Other strategies may be implemented that cool the space below the heating setpoint and adjust the morning heating setpoint to avoid morning reheating.

## SECTION C407
## TOTAL BUILDING PERFORMANCE

**C407.1 Scope.** This section establishes criteria for compliance using total building performance. All systems and loads shall be included in determining the total building performance including, but not limited to: Heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.

**EXCEPTION:** Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes.

**C407.2 Mandatory requirements.** Compliance with Section C407 also requires compliance with those sections shown in Table C407.2.

The building permit application for projects utilizing this method shall include in one submittal all building and mechanical drawings and all information necessary to verify that the building envelope and mechanical design for the project corresponds with the annual energy analysis. If credit is proposed to be taken for lighting energy savings, then an electrical permit application shall also be submitted and approved prior to the ((~~issuance of the building permit~~)) start of building construction. 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 in the baseline in accordance with ANSI/ASHRAE/IESNA 90.1 Appendix G and in the proposed model in accordance with the requirements of the ((~~Washington State~~)) Seattle Energy Code.

**Table C407.2**
**Mandatory Compliance Measures for Total Building Performance Method**

| Section[a] | Title | Comments |
|---|---|---|
| **Envelope** | | |
| ((~~C401~~)) C401.4 | Thermal envelope certificate | |
| C402.2.7 | Airspaces | |
| C402.5 | Air leakage | |
| **Mechanical** | | |
| C403.1.2 | Calculation of heating and cooling loads | |
| C403.1.3 | Data centers | |

**Table C407.2—continued**
**Mandatory Compliance Measures for Total Building Performance Method**

| Section[a] | Title | Comments |
|---|---|---|
| C403.2 | System design | |
| C403.3.1 | Equipment and system sizing | |
| C403.3.2 | HVAC equipment performance requirements | |
| C403.3.3 | Hot gas bypass limitation | |
| C403.3.4.4 | Boiler turndown | |
| ((~~C403.3.6~~ | ~~Ventilation for Group R occupancy~~)) | |
| C403.4.1 | Thermostatic controls | |
| C403.4.2 | Off-hour controls | |
| C403.4.7 | Combustion heating equipment controls | |
| C403.4.8 | Group R-1 hotel/motel guestrooms | See Section C403.7.4 |
| C403.4.9 | Group R-2 and R-3 dwelling units | |
| C403.4.10 | Group R-2 sleeping units | |
| C403.4.11 | Direct digital control systems | |
| C403.5.5 | Economizer fault detection and diagnostics (FDD) | |
| C403.7 | Ventilation and exhaust systems | Except for C403.7.6.2 |
| C403.8 | Fan and fan controls | |
| C403.9.1.1 | Variable flow controls | For cooling tower fans ≥ 7.5 hp |
| ((~~C403.9.1.2~~)) C403.9.1.3 | Limitation on centrifugal fan cooling towers | For open cooling towers |
| C403.10 | Construction of HVAC elements | |
| C403.11 | Mechanical systems located outside of the building thermal envelope | |
| C403.14 | Commissioning | |
| **Service Water Heating** | | |
| C404 | Service water heating | Except for C404.2.1 |
| **Lighting and Electrical** | | |
| C405 | Electrical power and lighting systems | |
| **Other Requirements** | | |
| C407 | Total building performance | |
| C408 | System commissioning | |
| C409 | Energy metering | |
| C410 | Refrigeration requirements | |
| C411[b] | Renewable energy | |
| C412 | Compressed air systems | |

a Reference to a code section includes all the relative subsections except as indicated in the table.
b Compliance with any of these sections includes compliance with any exception to that section.

**C407.3 Performance-based compliance.** Compliance with this section requires compliance with ASHRAE Standard 90.1 Appendix G, Performance Rating Method, in accordance with Standard 90.1 Section 4.2.1 with the following modifications:

1. The mandatory requirements of the ((~~Washington State~~)) Seattle Energy Code are required to be met, instead of those of Section G1.2.1a of ANSI/ASHRAE/IESNA 90.1
2. Compliance with Section C407 requires meeting both a regulated site energy target and a total site energy reduction target in accordance with the following:
   2.1. Regulated site energy target. The regulated site energy target is focused on regulated load energy efficiency, thus shall be met only via regulated load savings without consideration of the contribution of on-site or off-site renewable energy or unregulated load savings. Adjustments to the PCI, to account for the contribution of renewable energy found in ANSI/ASHRAE/IESNA 90.1 Section 4.2.1.1 shall not be used. References to energy cost in Section 4.2.1.1 and Appendix G shall be replaced by site energy use. Heating or cooling energy provided by a district energy system may utilize coefficient of performance (COP) ratios acceptable to the *code official* for the respective district energy sources. The building performance factors in Table 4.2.1.1 of ANSI/ASHRAE/IESNA 90.1 shall be replaced with those in Table C407.3(2).

2.2. Total site energy target. The total site energy performance target shall be met including the contributions of on-site or off-site renewable energy as described in Section C411.2 as well as the contributions of improvements in unregulated loads as allowed by Section C407.3.4. The annual on-site and off-site renewable energy production (as adjusted by the factors in Table C411.2.1) shall be subtracted from the proposed building annual site energy use. Compliance with the site energy performance target requires that the proposed building site energy use/baseline building site energy use is less than or equal to the site energy performance target from Table C407.3(3).

3. Documentation requirements in Section G1.3.2.d shall be replaced by a list showing compliance with the mandatory provisions of Table C407.2.
4. Forms demonstrating compliance with Appendix G developed by the U.S. Department of Energy shall be completed and submitted to the *code official*. The forms are available at energycodes.gov/ashrae-standard-901-performance-based-compliance-form.
5. References to yet-to-be-designed future building components in the Proposed Building Performance column of Table G3.1 shall be modified to reference the corresponding sections of the ((~~Washington State~~)) Seattle Energy Code in lieu of the requirements of ANSI/ASHRAE/IESNA 90.1 in the following sections of the table:
   5.1. No. 1, Design Model, subclause c.
   5.2. No. 6, Lighting, subclause c.
   5.3. No. 11, Service Water Heating System, subclause c.
   5.4. No. 12, Receptacle and Other Loads, subclause b.
6. HVAC systems, subclauses c and d of Table G3.1, shall meet the following requirements:
   6.1. For yet-to-be-designed systems in office, retail, library, education, and multifamily buildings and occupancies subject to the TSPR requirements of Section C403.1.1, the system type and efficiency parameters in the proposed model shall meet but not exceed those shown in Table D602.11 Standard Reference Design HVAC Systems.
   6.2. For all other buildings and occupancies, the system type shall be the same as the system modeled in the baseline design and shall comply with but not exceed the requirements of Section C403 in lieu of ANSI/ASHRAE/IESNA 90.1.
   6.3. For HVAC systems serving future tenant spaces, where the current building permit applies to only a portion of an HVAC system, and future components will receive HVAC services from systems included in the current building permit, those future components shall be modeled as the type required to complete the HVAC system portions under the current permit and shall meet but not exceed the requirements found in Section C403.
7. The requirements for proposed and baseline building lighting system shall be modified in accordance with Addendum af to ANSI/ASHRAE/IESNA 90.1.
8. Energy modeler qualifications. The energy analyst in responsible charge of the Section C407 submittal shall meet at least one of the following:
   8.1. ASHRAE Building Energy Modeling Professional (BEMP) certification.
   8.2. Association of Energy Engineer's Building Energy Simulation Analyst (BESA) certification.
   8.3. Successful completion of at least five projects modeled following any version of ANSI/ASHRAE/IESNA 90.1 Appendix G within the last three years that were reviewed and approved by a *code official* or rating authority.

**SDCI Informative Note:** The permit applicant is encouraged to schedule a pre-application meeting to discuss the modeling approach for any yet-to-be designed areas that are not included in the C407 permit submissions. In general, future permit submissions should not contribute energy savings to the C407 submission beyond prescriptive code requirements, assuming use of the base building HVAC systems. Future systems must be modeled for the base building permit as being no better than the current prescriptive code, because plans often change and the City does not have a mechanism for ensuring that future tenant projects meet any beyond-code performance modeled in the original C407 submission.

**Table C407.3(1)**
**((~~Carbon Emissions Factors~~)) Reserved**

| ((~~Type~~ | ~~CO2e (lb/unit)~~ | ~~Unit~~ |
|---|---|---|
| ~~Electricity~~ | ~~0.44~~ | ~~kWh~~ |
| ~~Natural gas~~ | ~~11.7~~ | ~~Therm~~ |
| ~~Oil~~ | ~~19.2~~ | ~~Gallon~~ |
| ~~Propane~~ | ~~10.5~~ | ~~Gallon~~ |
| ~~Other*~~ | ~~195.00~~ | ~~mmBtu~~ |
| On-site renewable energy | ~~0.00~~)) | |

((~~*District energy systems may use alternative emissions factors supported by calculations approved by the *code official*.~~))

**Table C407.3(2)**
**Building Performance Factors (BPF) to be used for Compliance with Section C407.3**

| Building Area Type | Building Performance Factor |
|---|---|
| Multifamily | ((~~0.51~~)) 0.45 |
| Health care/hospital | 0.70 |
| Hotel/motel | ((~~0.51~~)) 0.46 |
| Office | 0.44 |
| Restaurant | 0.33 |
| Retail | 0.41 |
| School | 0.35 |
| Warehouse | 0.18 |
| All others | 0.43 |

**Table C407.3(3)**
**Site Energy Performance Targets to be used for Compliance with Section C407.3**

| Building Area Type | Site Energy Performance Targets |
|---|---|
| Multifamily | ((~~0.59~~)) 0.53 |
| Health care/hospital | 0.72 |
| Hotel/motel | ((~~0.62~~)) 0.56 |
| Office | 0.58 |
| Restaurant | 0.59 |
| Retail | 0.46 |
| School | 0.52 |
| Warehouse | 0.29 |
| All others | 0.55 |

**C407.3.1 Limits on ((~~nonmandatory measures~~)) substandard building envelopes.** The Proposed Total UA of the proposed building shall be no more than ((~~20~~)) 10 percent higher than the Allowed Total UA as defined in Section C402.1.5.

**C407.3.2 On-site and off-site renewable energy accounting for use with Appendix G.** Qualifying on-site and off-site renewable energy delivered or credited to the building project to comply with Section C407.3 item 2.2 shall meet the requirements of Section C411.2.

**C407.3.3 Low-carbon district energy use with Appendix G.** Qualifying *low-carbon district heating and cooling or heating only systems* and *low-carbon district energy exchange systems* shall meet the requirements of Section C407.3.3.1 or C407.3.3.2, as applicable.

**C407.3.3.1 Utilization of low-carbon district heating and cooling or heating only systems.** Applicable if heating and cooling or heating only is provided to the *proposed building* from a *low-carbon district heating and cooling or heating only system* that is fully operational prior to the final inspection. Proposed model shall account for all on-site HVAC and service hot water related equipment, such as circulation pump energy and heat-exchanger efficiency.

1. The following modifications shall be applied to Appendix G of ANSI/ASHRAE/IESNA 90.1 in addition to what is described in Section C407.3:

1.1. For low-carbon district heating and cooling systems, strike the text of Sections G3.1.1.1, G3.1.1.2, G3.1.1.3.1, G3.1.1.3.3, and G3.1.1.3.4. Baseline system shall be selected based on unmodified versions of Tables G3.1.1-3 and G3.1.1-4, comparing energy use to determine compliance.

1.2. For low-carbon district heating only systems, strike the text of Sections G3.1.1.1, G3.1.1.3.1, and G3.1.1.3.4. Baseline system shall be selected based on unmodified versions of Tables G3.1.1-3 and G3.1.1-4, ((~~with carbon emission factors from Table C407.3(1)~~)) comparing energy use to determine compliance.

2. Any heating or cooling energy provided by the *low-carbon district heating and cooling or heating only system* shall utilize a calculated energy use reduction factor acceptable to the code official to account for energy use reduction from those end uses.

3. Energy "credit" for any waste/recoverable heat exported to the *low-carbon district heating and cooling or heating only systems* shall be accounted for in the proposed design by multiplying the quantity of heat exported by the appropriate seasonal utilization factor in Items 3.1 and 3.2 below. This energy "credit" is subtracted from the total proposed design energy use calculated in accordance with ASHRAE 90.1 Section 4.2.1.1.

3.1. Fifty percent of the waste heat exported to the *low-carbon district heating and cooling or heating only systems* during the months of October through December and January through March.

3.2. Twenty-five percent of the waste heat exported to the *low-carbon district heating and cooling or heating only systems* during the months of April through September.

**EXCEPTION:** Waste heat exported from the building to the *low-carbon district heating and cooling or heating only system* shall not be subtracted from the proposed design energy use if they are already accounted for in the calculation of energy use from the district heating or cooling plant as part of the *district energy efficiency factor*.

Documentation for the low-carbon district system that is operational prior to the final inspection shall be provided to demonstrate the following:

1. Distribution losses must be accounted for and may not exceed 10 percent of the annual load delivered to buildings served by the system.

2. Twenty-five percent of the annual district-system-net-load-met (sum of heating and cooling energy provided to attached buildings) comes from heat recovery between connected buildings, waste heat or renewable energy resources and no more than 25 percent of the annual heat input to the system comes from fossil fuel or electric-resistance sources, or not more than 10 percent of the system annual heat input to the system comes from fossil fuel or electric-resistance sources.

**C407.3.3.2 Utilization of low-carbon district energy exchange systems.** Applicable if heating or cooling is provided to the *proposed building* from a *low-carbon district energy exchange system* that is fully operational prior to the final inspection. Proposed model shall account for all on-site HVAC and service hot water related equipment, such as circulation pump energy and heat-exchanger efficiency.

1. The following modifications shall be applied to Appendix G of ANSI/ASHRAE/IESNA 90.1 in addition to what is described in Section C407.3:

1.1. Strike the text of Sections G3.1.1.1, G3.1.1.2, G3.1.1.3, G3.1.1.3.1, G3.1.1.3.2, G3.1.1.3.3, and G3.1.1.3.4. Baseline system shall be selected based on unmodified versions of Tables G3.1.1-3 and G3.1.1-4.

2. Any heating or cooling energy provided by a low-carbon district energy exchange system shall utilize a calculated energy use reduction factor acceptable to the *code official* to account for the reduction in the proposed model.

3. Energy use "credit" for any waste/recoverable heating exported to the *low-carbon district energy exchange system* shall be accounted for in the proposed design by multiplying the quantity of heat exported by the appropriate seasonal utilization factor in Items 3.1 and 3.2 below. This energy use "credit" is subtracted from the total proposed design energy use calculated in accordance with ASHRAE 90.1 Section 4.2.1.1.

3.1. Fifty percent of the waste heat exported to the *low-carbon district energy exchange system* during the months of October through December and January through March.

3.2. Twenty-five percent of the waste heat exported to the *low-carbon district energy exchange system* during the months of April through September.

**EXCEPTION:** Waste heat exported from the building to the *low-carbon district heating and cooling or heating only system* shall not be subtracted from the proposed design energy use if they are already accounted for in the calculation of energy use from the district heating or cooling plant as part of the *district energy efficiency factor*.

Documentation for the low-carbon district system that is operational prior to the final inspection shall be provided to demonstrate that the definition of *low-carbon district energy exchange system* is satisfied.

**C407.3.4 Credit for improvements in unregulated loads when using Appendix G.** When calculating savings for site energy targets in accordance with Section C407.3 item 2.2, but not when calculating savings for ((~~emissions~~)) site energy targets in accordance with Section C407.3 item 2.1, differences in the simulation of unregulated loads and equipment modeled in the baseline building design from those in the *proposed design* shall be approved by the *code official* based on documentation that the equipment installed in the *proposed design* represents a significant verifiable departure from documented current conventional practice. All unregulated equipment for which savings is claimed must be installed by the time of final inspection. The burden of this documentation is to demonstrate that accepted conventional practice would result in baseline building equipment different from that installed in the *proposed design*. Occupancy and occupancy schedules shall not be changed.

**C407.3.4.1 Approved unregulated load types.** Unregulated load types for which reductions of energy use are claimed shall be one of those listed in Table C407.3.4.1 or shall be *approved* and publicly listed by SDCI. Requests for approval of such load types shall include the identification with predicted energy use of the baseline case in addition to the identification with predicted energy use of the proposed alternate. Listings for specific load types may be withdrawn and made unavailable for subsequent permit applications in cases by SDCI where it is considered that the unregulated load type listed has become accepted conventional practice. Unregulated load savings shall follow the methodology outlined in this section, and not use the language from Appendix G Table G3.1 - No. 12 Receptacle and Other Load Baseline Building Performance Exception.

**Table C407.3.4.1**
**Approved Unregulated Load Types**

| In compliance with the requirements of section | Predicted energy reductions (%) | |
|---|---|---|
| | Group R-1 | Group R-2 |
| C406.2.15, Enhanced residential kitchen equipment | 1.2 | 1.9 |
| C406.2.16, Enhanced residential laundry equipment | N/A | 0.6 |
| C406.2.17, Heat pump clothes dryers | 0.6 | 0.6 |

## SECTION C408
## SYSTEM COMMISSIONING

**C408.1 General.** A building commissioning process led by a *certified commissioning professional* and functional testing requirements shall be completed for mechanical systems in Section C403; service water heating systems in Section C404; controlled receptacle and lighting control systems in Section C405; equipment, appliances and systems installed to comply with Sections C406 or C407; energy metering in Section C409; and refrigeration systems in Section C410.

**EXCEPTION:** Buildings, or portions thereof, which are exempt from Sections C408.2 through C408.7 may be excluded from the commissioning process.

1. Mechanical systems that are not required to comply with Section C403.3.5 are exempt from the commissioning process where the installed total mechanical equipment capacity is less than 180,000 Btu/h (15 tons) cooling capacity and less than 240,000 Btu/h (20 tons) heating capacity and energy recovery ventilation (ERV) equipment is less than 300 cfm capacity.
2. Service water heating systems are exempt from the commissioning process in buildings where the largest service water heating system capacity is less than 200,000 Btu/h and where there are ((~~any~~)) none of the following:
   2.1. ((~~No~~)) pools or permanent spas.
   2.2. ((~~No~~)) solar thermal water heating.
   2.3. ((~~No~~)) recirculation pumps.
   2.4. ((~~No~~)) heat pump water heaters, except fully-packaged for individual residential dwelling unit use.
3. Lighting control systems are exempt from the commissioning process in buildings where both the total installed lighting load is less than 10 kW and the lighting load controlled by occupancy sensors or automatic daylighting controls is less than 5 kW.
4. Refrigeration systems are exempt from the commissioning process in buildings if they are limited to self-contained units.

**C408.1.1 Commissioning in construction documents.** Construction documents shall clearly indicate provisions for commissioning process. Electrical permit documents shall indicate required commissioning work for lighting and metering systems, and mechanical permit documents shall indicate required commissioning work for mechanical and water heating systems. The construction documents shall minimally include the following:

1. A narrative description of the activities that will be accomplished during the commissioning process. At a minimum, the commissioning process is required to include:
   1.1. Development and execution of the commissioning plan, including all subsections of Section C408.1.2;
   1.2. The *certified commissioning professional's* review of the building documentation and close out submittals in accordance with Section C103.6; and
   1.3. The commissioning report in accordance with Section C408.1.3.
2. Roles, responsibilities, and required qualifications of the *certified commissioning professional*.
3. A listing of the specific equipment, appliances, or systems to be tested.

**C408.1.2 Commissioning plan.** A commissioning plan shall be developed by the project's *certified commissioning professional*, shall be submitted to SDCI prior to the first mechanical inspection, and shall outline the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities, systems testing and balancing, functional performance testing, and verification of the building documentation requirements in Section C103.6.
2. Roles and responsibilities of the commissioning team, including the name and statement of qualifications of the *certified commissioning professional*.
3. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.

**C408.1.2.1 In-house commissioning disclosure and conflict management plan.** Where the *certified commissioning professional's* contract or employment is other than directly with the building owner, an in-house commissioning disclosure and conflict management plan shall be a part of the commissioning process. A copy shall be included in the commissioning plan. This plan shall disclose the *certified commissioning professional's* contractual relationship with other team members and provide a conflict management plan demonstrating that the *certified commissioning professional* is free to identify any issues discovered and report directly to the owner.

**C408.1.2.2 Functional performance testing.** Functional performance testing shall be conducted for mechanical systems in Sections C403; service water heating systems in Section C404; controlled receptacles and lighting control systems in Section C405; equipment, appliances, systems installed to comply with Section C406 or C407; energy metering in Section C409; and refrigeration systems in Section C410. Written procedures which clearly describe the individual systematic test procedures, the expected system response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion shall be followed. This testing shall include control systems which will be tested to document that control devices, components, equipment, and systems are calibrated and adjusted to operate in accordance with approved construction documents. Testing shall affirm the conditions required within Sections C408.2 through C408.7 under system testing.

**C408.1.2.3 Functional performance testing - Sampling.** For projects with 7 or fewer similar systems, each system shall be tested. For projects with more than 7 systems, testing shall be done for each unique combination of control types. Where multiples of each unique combination of control types exist, no fewer than 20 percent of each combination shall be tested unless the code official or design professional requires a higher percentage to be tested. Where 30 percent or more of the tested system fail, all remaining identical combinations shall be tested.

**C408.1.2.4 Deficiencies.** Deficiencies found during testing shall be resolved including corrections and retesting.

**C408.1.3 Commissioning report.** A commissioning report shall be completed and certified by the *certified commissioning professional* and delivered to the building owner or owner's authorized agent. The report shall be organized with mechanical, service water heating, controlled receptacle and lighting control systems, energy metering, and refrigeration findings in separate sections to allow independent review. The report shall record the activities and results of the commissioning process and be developed from the final commissioning plan with all of its attached appendices. The report shall be submitted to SDCI prior to the final inspection 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. Commissioning plan.
5. Testing, adjusting and balancing report.

**EXCEPTION:** Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.

**C408.1.4 Commissioning process completion requirements.** Prior to the final mechanical, plumbing and electrical inspections or obtaining a certificate of occupancy, the *certified commissioning professional* shall provide evidence of *building commissioning* in accordance with the provisions of this section.

**C408.1.4.1 Commissioning compliance.** ((~~Buildings, or portions thereof, shall not be considered acceptable for a final inspection pursuant to Section C104.2.6 until the code official has received a letter of transmittal from the building owner acknowledging that the building owner or owner's authorized agent has received the Commissioning Report. Completion of Commissioning Compliance Checklist (Figure C408.1.4.1) is deemed to satisfy this requirement. Phased acceptance of Commissioning Compliance Checklist for portions of the work specific to the trade that is being inspected is permissible where accepted by the code official and where the certified commissioning professional remains responsible for completion of the commissioning process. If there are unresolved deficiencies when the final inspection is scheduled, the Commissioning Report shall be submitted and shall describe the unresolved deficiencies.~~

~~**C408.1.4.2 Copy of report.** The code official shall be permitted to require that a copy of the Commissioning Report be made available for review by the code official.~~))

The mechanical and water heating portions of the commissioning report, in compliance with Sections C408.2, C408.3, and C408.7, shall be submitted to SDCI prior to completion and approval of mechanical permit final inspection.

The controlled receptacle, lighting, and metering portions of the commissioning report, in compliance with Sections C408.4 and C408.6, shall be submitted to SDCI prior to completion and approval of electrical permit *final inspection*.

The following items shall be submitted to SDCI prior to completion and approval of *final inspection* as per Seattle Building Code Section 108.9.10 to demonstrate commissioning compliance:

1. Full commissioning report, in compliance with Section C408.1.3.
    a. The commissioning report shall include a list of all unresolved deficiencies and any incomplete commissioning work required by Section C408, with description and anticipated date of completion for each, or a statement signed by the *certified commissioning professional* attesting to successful commissioning of the entire project with no unresolved deficiencies or incomplete tests.
    b. Where tenant spaces will be built out under separate permits, the commissioning report shall describe the *certified commissioning professional's* scope of work required to complete commissioning of the central building HVAC systems and lighting control systems as the tenant spaces are completed.
2. Commissioning checklist, from Figure C408.1.4.1, signed by the *certified commissioning professional*.
3. Statement that the owner has received a copy of the commissioning report, signed by the owner or owner's authorized agent.

**C408.1.4.1.1 Post-occupancy commissioning completion.** Where there are unresolved deficiencies or other incomplete commissioning tasks that conflict with requirements of this code, the applicant shall comply with the requirements of one of the following three options.

1. In addition to the Temporary Certificate of Occupancy requirements of SBC 109.4, SDCI may issue a temporary certificate of occupancy (TCO) to remain in effect pending resolution of commissioning issues. Applicant must complete all outstanding commissioning work and complete a revised commissioning report before SDCI will issue a final Certificate of Occupancy.
2. Applicant must post a performance bond in the amount of 2 percent of the building permit project valuation as determined in accordance with the *fee subtitle*, to ensure completion of the required commissioning work within 12 months.
3. Applicant must obtain electrical and mechanical permits as required to incorporate all remaining electrical and mechanical work, including required commissioning of those systems. Applicant must complete all outstanding electrical and mechanical commissioning work and complete a revised commissioning report prior to completion and approval of final inspection for those permits.

**SDCI Informative Note:** An electronic version of the Commissioning Compliance Checklist is available on the SDCI Seattle Energy Code web page.

**C408.2 Mechanical systems commissioning.** Mechanical equipment and controls subject to Section C403 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include all energy code requirements for which the code states that equipment or controls shall "be capable of" or "configured to" perform specific functions.

**Exception:** Mechanical systems are exempt from the commissioning process where the installed total mechanical equipment capacity is less than ((~~240,000~~)) 180,000 Btu/h cooling capacity and less than ((~~300,000~~)) 240,000 Btu/h heating capacity, and energy recovery ventilation (ERV) equipment is less than 300 cfm capacity.

**C408.2.1 Reserved.**

**C408.2.2 Systems adjusting and balancing.** HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within the tolerances provided in the project specifications. Test and balance activities shall include air system and hydronic system balancing.

**C408.2.2.1 Air systems balancing.** Each supply air outlet and *zone* terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the *International Mechanical Code*. Discharge dampers used for air system balancing are prohibited on constant volume fans and variable volume fans with motors 10 hp (18.6 kW) and larger. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp (0.74 kW), fan speed shall be adjusted to meet design flow conditions.

**EXCEPTION:** Fans with fan motors of 1 hp (0.74 kW) or less.

**C408.2.2.2 Hydronic systems balancing.** Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the capability to measure pressure across the pump, or test ports at each side of each pump.

**EXCEPTION:** The following equipment is not required to be equipped with means for balancing or measuring flow:

1. Pumps with pump motors of 5 hp (3.7 kW) or less.
2. Where throttling results in no greater than five percent of the nameplate horsepower draw above that required if the impeller were trimmed.

**C408.2.3 System testing.** Functional performance testing shall demonstrate the components, systems, and system-to-system interfacing relationships are installed and operate in accordance with *approved* construction documents. Testing shall include the *sequence of operation*, and be conducted under full-load, part-load and the following conditions:

1. All modes as described in the *sequence of operation*;
2. Redundant or *automatic* back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

**C408.3 Service water heating systems commissioning.** Service water heating equipment and controls subject to Section C404 shall be included in the commissioning process required by Section C408.1. The commissioning process shall minimally include equipment and components installed to meet all energy code requirements for devices to "start," "automatically turn off," "automatically adjust," "limit operation," and "limit the temperature" and "be configured to."

**C408.3.1 System testing.** Functional performance testing shall demonstrate that heaters, piping, distribution systems, and system-to-system interfacing relationships are installed and operate in accordance with *approved* construction documents. Testing shall include the *sequence of operation*, and be conducted under at least 50 percent water heating load, part-load and the following conditions:

1. Normal operation;
2. Redundant or *automatic* back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

**C408.4 Controlled receptacle and lighting control system commissioning.** *Controlled receptacles* and lighting control systems subject to Section C405 shall be included in the commissioning process required by Section C408.1. The configuration and function of *controlled receptacles* and lighting control systems required by this code shall be tested and shall comply with Section C408.4.1.

**EXCEPTION:** Lighting control systems and *controlled receptacles* are exempt from the commissioning process in buildings where:

1. The total installed lighting load is less than 20 kW, and
2. The lighting load controlled by occupancy sensors or *automatic* daylighting controls is less than 10 kW.

**C408.4.1 System testing.** Functional performance testing shall demonstrate that occupant sensors, time switches, manual overrides, ((~~night sweep-off~~)) time switch scheduled lighting shutoff, *daylight responsive control*, and *controlled receptacles* are installed and operate in accordance with *approved* construction documents. Testing shall include the *sequence of operation* and be conducted under the following conditions:

1. Normal operation;
2. Redundant or *automatic* back-up mode;

3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

**C408.5 Systems installed to meet Section C406 or C407.** Equipment, components, controls or configuration settings for systems which are included in the project to comply with Section C406 or C407 shall be included in the commissioning process required by Section C408.1.

**C408.5.1 System testing.** Functional performance testing for these appliances, equipment, components, controls and/or configuration settings shall demonstrate operation, function and maintenance serviceability for each of the commissioned systems in accordance with the *approved* construction documents.

**C408.6 Metering system commissioning.** Energy metering systems required by Section C409 shall comply with Section C408.6 and be included in the commissioning process required by Section C408.1. The commissioning process shall include all energy metering equipment and controls required by Section C409.

**C408.6.1 System testing.** Functional performance testing shall demonstrate that energy source meters, end-use meters, *data acquisition systems*, and energy displays are installed and operate in accordance with *approved* construction documents. At a minimum, testing shall confirm that:

1. The metering system devices and components work properly under low and high load conditions.
2. The metered data is delivered in a format that is compatible with the data collection system.
3. The energy display is in a location with *access* to building operation and management personnel.
4. The energy display meets code requirements regarding views required in Section C409.4.3. The display shows energy data in identical units (e.g., kWh).

**C408.7 Refrigeration system commissioning.** All installed refrigeration systems subject to Section C410 shall be included in the commissioning process required by Section C408.1.

**EXCEPTIONS:**

1. Self-contained refrigeration systems are exempt from the commissioning process.
2. Total installed capacity for refrigeration is equal to or less than 240 kBtu/h.

**C408.7.1 System Testing.** Functional performance testing shall demonstrate that compressors, heat exchangers, piping, distribution systems, and system-to-system interfacing relationships are installed and operate in accordance with *approved* construction documents. Testing shall include the *sequence of operation* and be conducted under full-load at, part-load and the following conditions:

1. Normal mode;
2. Redundant or *automatic* back-up mode;
3. Performance of alarms; and
4. Mode of operation upon a loss of power and restoration of power.

## SECTION C409
## ENERGY METERING AND ENERGY CONSUMPTION MANAGEMENT

**C409.1 General.** All new buildings and additions shall have the capability of metering all source energy usage in accordance with Section C409.2 in addition to the source energy for on-site renewable energy production in accordance with Section C409.2.4 and the end-use energy usage for electric vehicle charging in accordance with Section C409.3.4. New buildings and additions with a gross conditioned floor area over ((~~25,000~~)) 20,000 square feet shall comply with Sections C409.2, C409.3, and C409.4. New buildings and additions 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. Existing buildings shall comply with the energy metering provisions of Section C506.1. For Group R-2 buildings, the floor area of *dwelling units* shall be excluded from the total *conditioned floor area* for the purposes of determining the 20,000 square foot threshold. *Alterations* and *additions* to existing buildings shall conform to Section C506.

**EXCEPTIONS:**

1. Tenant spaces smaller than ((~~25,000~~)) 20,000 $ft^2$ square feet within buildings if the tenant space has its own utility service and utility meters shall comply with Section C409.2 and are exempt from the end-use metering, measurement devices, data acquisition system and energy display requirements of Sections C409.3 and C409.4, but are not exempt from the electric vehicle charging end-use metering requirements of C409.3.4.
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 shall comply with Section C409.2 and are exempt from the end-use metering, measurement devices, data acquisition system and energy display requirements of

Sections C409.3 and C409.4, but are not exempt from the electric vehicle charging end-use metering requirements of C409.3.4.

3. Group R-2 buildings with more than 20,000 square feet of conditioned floor area not occupied by dwelling units, and not exempt from end-use metering in accordance with Exception 1 of C409.1, are permitted to provide 0.12 watts of renewable energy per square foot of gross conditioned floor area, or 15 additional C406 credits, in lieu of the end-use metering systems required by this section. The renewable energy or C406 credits provided must be in addition to the renewable energy and C406 credits required cumulatively by all other sections of this code. Common areas in Group R-2 buildings using this exception are exempt from the end-use metering, measurement device, data acquisition system, and energy display requirements of Section C409.3 and C409.4, but not exempt from the electrical vehicle charging end-use metering requirements of C409.3.4.

**SDCI Informative Note:** Seattle's "Building Tune-ups" ordinance will continue to be in effect, requiring buildings with over 50,000 square feet of *conditioned floor area* to periodically assess and optimize the functioning of energy-consuming systems. The cost and complexity of these tune-ups can potentially be minimized by careful configuration of the metering system.

**C409.1.1 Alternate metering methods.** Where approved by the building official, energy use metering systems may differ from those required by this section, provided that they are permanently installed and that the source energy measurement, end use category energy measurement, data storage and data display have similar accuracy to and are at least as effective in communicating actionable energy use information to the building management and users, as those required by this section.

**C409.1.2 Conversion factor.** Any threshold stated in kW shall include the equivalent BTU/h heating and cooling capacity of installed equipment at a conversion factor of 3,412 Btu per kW or 2,730 Btu per kVA.

**C409.1.3 Dwelling units.** See Sections C404.9 and C405.7 for additional metering requirements for Group R-2 dwelling units.

**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 exceptions 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. For buildings exempt from data collection systems, the data from these meters is permitted to either be stored locally using a manual totalizing meter or other means at the meter or fed into a central data collection system.

**C409.3 End-use metering.** Meters shall be provided to collect energy use data for each end-use category listed in Sections C409.3.1 through C409.3.7. These meters shall collect data for the whole building or for each separately metered portion of the building where not exempted by the exception to Section C409.1. Not more than 10 percent of the total connected load of any of the end-use metering categories in Sections C409.3.1 through C409.3.6 is permitted to be excluded from that end-use data collection. Not more than 10 percent of the total connected load of any of the end-use metering categories in Sections C409.3.1 through C409.3.6 is permitted to consist of loads not part of that category. Multiple meters may be used for any end-use category, provided that the *data acquisition system* totals all of the energy used by that category. Full-floor tenant space submetering data shall be provided to the tenant in accordance with Section C409.7, and the data shall not be required to be included in other end-use categories.

**EXCEPTIONS:**

1. HVAC and service water heating equipment serving only an individual *dwelling unit* or sleeping unit does not require end-use metering.
2. Separate metering is not required for fire pumps, stairwell pressurization fans or other life safety systems that operate only during testing or emergency.
3. End use metering is not required for individual tenant spaces not exceeding 2,500 square feet in floor area when a dedicated source meter meeting the requirements of Section C409.4.1 is provided for the tenant space.
4. 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 as identified in Section 517 of the Seattle Electrical Code except that submetering is required for the following load categories:
   4.1. HVAC system energy use in accordance with the requirements of Section C409.3.1.
   4.2. Service water heating energy use in accordance with the requirements of Section C409.3.2.
   4.3. Process load system energy in accordance with the requirements of Section ((~~C409.3.5~~)) C409.3.6 for each significant facility not used in direct patient care, including but not limited to, food service, laundry and sterile processing facilities, where the total connected load of the facility exceeds 100 kVA.
5. End-use metering is not required for electrical circuits serving only ((~~land~~)) hotel rooms and guest suites within Group R-1 occupancies. This exception does not apply to common areas or to equipment serving multiple sleeping rooms.

**C409.3.1 HVAC system energy use.** This category shall include all energy including electrical, gas, liquid fuel, district steam and district chilled water that is used by boilers, chillers, pumps, fans and other equipment used to provide space heating, space cooling, dehumidification and ventilation to the building, but not including energy that serves process loads, service water heating or miscellaneous loads as defined in Section C409.3. Multiple HVAC energy sources, such as gas, electric and steam, are not required to be summed together.

**EXCEPTIONS:**

1. 120 volt equipment.
2. An HVAC branch circuit where the total MCA of equipment served equates to less than 10 kVA.
3. Individual fans or pumps that are not on a variable frequency drive.

**C409.3.2 Service water heating energy use.** This category shall include all energy used for heating of domestic and service hot water, but not energy used for space heating.

**EXCEPTION:** Service water heating energy use less than 50 kVA does not require end-use metering.

**C409.3.3 Lighting system energy use.** This category shall include all energy used by interior and exterior lighting, including lighting in parking structures and lots, but not including plug-in task lighting.

**C409.3.4 Electric vehicle charging energy use.** This category shall include all energy used for electrical vehicle charging. For buildings exempt from data collection systems, the data from these meters is permitted to either be stored locally using a manual totalizing meter or other means at the meter or fed into a central data collection system.

**C409.3.5 Plug load system energy use.** This category shall include all energy used by appliances, computers, plug-in task lighting, and other equipment or equipment covered by other end-use metering categories listed in Section C409.3. In a building where the main service is 480/277 volt, each 208/120 volt panel is permitted to be assumed to serve only plug load for the purpose of Section C409, unless it serves nonresidential refrigeration or cooking equipment.

**EXCEPTIONS:**

1. Where the total connected load of all plug load circuits is less than 50 kVA, end-use metering is not required.
2. Electric receptacles located in fire-rated or smoke-rated corridors, enclosed stairwells, or egress passageways are not required to be metered.

**C409.3.6 Process load system energy use.** This category shall include all 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:** Where the process load energy use is less than 50 kVA, end-use metering is not required.

**C409.3.7 Full-floor tenant space electrical submetering.** In a multi-tenant building where more than 90 percent of the leasable area of a floor is occupied by a single tenant, an electrical energy use display shall be provided to the tenant in accordance with the requirements of Section C409.4.3. Electrical loads from areas outside of the tenant space or from equipment that serves areas outside of the tenant space shall not be included in the tenant space submetering. A single display is permitted to serve multiple floors occupied by the same tenant.

**C409.4 Measurement devices, data acquisition system and energy display.**

**C409.4.1 Meters.** Meters and other measurement devices required by this section shall be configured to automatically communicate energy data to a data acquisition system and energy display. 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 data that is fully integrated into the data acquisition and display system per the requirements of Section C409. Electrical meters shall be configured to communicate data to the data acquisition system and energy display for both consumption (e.g., kWh) and consumption rate (e.g., kW). Other meters and measurement devices shall be configured to communicate data to the data acquisition system for consumption.

**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*.

**C409.4.2 Data acquisition system.** The data acquisition system shall store the data from the required meters and other sensing devices in a single database for a minimum of 36 months. For each energy supply and end use category required by C409.2 and C409.3, it shall provide energy consumption logged in one-hour or less intervals and energy consumption rate logged in 10-minute or less intervals. Data from the data acquisition system shall be viewable via the energy display in accordance with the requirements of Section C409.4.3.

**C409.4.3 Energy display.** For each building subject to Section C409.2 and C409.3, either a single visible display in a location with *ready access*, or a single web page or other electronic document available for access to building operation and management personnel or to a third-party energy data analysis service shall be provided in the building; for metering data acquisition systems and energy displays monitored by a third-party energy data analysis service, building operation and management personnel shall retain access to the metering data acquisition system and energy display. The display shall numerically provide the current energy consumption rate and energy consumption total for each whole building energy source and each end use category. The energy display shall also graphically and numerically display logged data from the data acquisition system for energy consumption for each whole building energy source and energy consumption rate for whole building electrical use and each end use category for any selected day, week, month, or year.

**C409.4.4 Commissioning.** Energy metering and energy consumption management systems shall be commissioned in accordance with Section C408.6.

## SECTION C410
## REFRIGERATION SYSTEM REQUIREMENTS

**C410.1 General.** Walk-in coolers, walk-in freezers, refrigerated warehouse coolers, refrigerated warehouse freezers, and refrigerated display cases shall comply with this Section. Where they comprise any portion of the thermal envelope of the building, they shall also comply with the requirements of Section C402, using the R-values or U-values listed in this Section C410. Section C402.1.5 component performance alternative is permitted to be used for the thermal envelope of the refrigerated space where *approved* by the *code official*.

**C410.2 Commercial refrigerators, freezers and refrigerator-freezers.** Refrigeration equipment, defined in DOE 10 C.F.R. Part 431.62, shall have an energy use in kWh/day not greater than the values of Table C410.2 when tested and rated in accordance with AHRI Standard 1200. The energy use shall be verified through certification under an approved certification program or, where a certification program does not exist, the energy use shall be supported by data furnished by the equipment manufacturer.

**C410.2.1 Refrigerated display cases.** Refrigerated display cases shall comply with the following:

1. Lighting in refrigerated display cases shall be controlled by one of the following:
   1.1. Time switch controls to turn off lights during nonbusiness hours. Timed overrides for display cases shall turn the lights on for up to 1 hour and shall automatically time out to turn the lights off.
   1.2. Motion sensor controls on each display case section that reduce lighting power by at least 50 percent within 3 minutes after the area within the sensor range is vacated.
2. Low-temperature display cases shall incorporate temperature-based defrost termination control with a time-limit default. The defrost cycle shall terminate first on an upper temperature limit breach and second upon a time limit breach.
3. Antisweat heater controls shall reduce the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.

**C410.3 Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers.** Site-assembled and site-constructed *walk-in coolers* and *walk-in freezers* and *refrigerated warehouse coolers* and *refrigerated warehouse freezers* shall comply with the following:

1. Automatic door-closers shall be provided that fully close walk-in doors that have been closed to within 1 inch (25 mm) of full closure.

   **EXCEPTION:** Automatic closers are not required for doors more than 45 inches (1143 mm) in width or more than 7 feet (2134 mm) in height.
2. Doorways shall be provided with strip doors, curtains, spring-hinged doors or other method of minimizing infiltration when doors are open.
3. *Walk-in coolers* and *refrigerated warehouse coolers* shall be provided with wall, ceiling, and door insulation of not less than R-25 or have wall, ceiling and door assembly *U*-factors no greater than *U*-0.039. *Walk-in freezers* and *refrigerated warehouse freezers* shall be provided with wall, ceiling and door insulation of not less than R-32 or have wall, ceiling and door assembly *U*-factors no greater than *U*-0.030.

   **EXCEPTION:** Insulation is not required for glazed portions of doors or at structural members associated with the walls, ceiling or door frame.
2. The floor of *walk-in coolers* shall be provided with floor insulation of not less than R-25 or have a floor assembly *U*-factor no greater than *U*-0.40. The floor of *walk-in freezers* shall be provided with floor insulation of not less than R-28 or have a floor assembly *U*-factor no greater than *U*-0.035.

   **EXCEPTION:** Insulation is not required in the floor of a *walk-in cooler* that is mounted directly on a slab on grade.
5. Transparent fixed window and reach-in doors for *walk-in freezers* and windows in *walk-in freezer* doors shall be provided with triple-pane glass, with the interstitial spaces filled with inert gas or be provided with heat-reflective treated glass.
6. Transparent fixed window and reach-in doors for *walk-in coolers* and windows for *walk-in coolers* doors shall be provided with double-pane or triple-pane glass, with interstitial space filled with inert gas, or be provided with heat-reflective treated glass.
7. Evaporator fan motors that are less than 1 hp (0.746 kW) and less than 460 volts shall be provided with electronically commutated motors, brushless direct-current motors, or 3-phase motors.
8. Condenser fan motors that are less than 1 hp (0.746 kW) shall use electronically commutated motors, permanent split capacitor-type motors or 3-phase motors.
9. Antisweat heaters that are not provided with antisweat heater controls shall have a total door rail, glass and frame heater power draw of not greater than 7.1 $W/ft^2$ (76 $W/m^2$) of door opening for *walk-in freezers* and not greater than 3.0 $W/ft^2$ (32 $W/m^2$) of door opening for *walk-in coolers*.
10. Where antisweat heater controls are provided, they shall be capable of reducing the energy use of the antisweat heater as a function of the relative humidity in the air outside the door or to the condensation on the inner glass pane.
11. Lights in *walk-in coolers*, *walk-in freezers*, *refrigerated warehouse coolers* and *refrigerated warehouse freezers* shall either be provided with light sources with an efficacy of not less than 40 lumens per watt, including ballast losses, or shall be provided with a device that automatically turns off the lights within 15 minutes of when the *walk-in cooler* or *walk-in freezer space* is not occupied.

12. Evaporator fans in refrigerated warehouses 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.

13. Where they comprise any portion of the thermal envelope of the building, the floor, wall, and ceiling components shall also comply with the requirements of Section C402, using the R-values or U-values listed in this Section C410.2. Section C402.1.5 component performance alternative is permitted to be used where *approved* by the *code official*.

**C410.3.1 Performance standards.** Site-assembled and site-constructed *walk-in coolers* and *walk-in freezers* shall meet the requirements of Tables C410.3.1(1), C410.3.1(2), and C410.2.1(3).

**Table C410.3.1(1)**
**Walk-in Cooler and Freezer Display Doors Efficiency Requirements**

| Class Description | Class | Maximum Energy Consumption (kWh/day)[a] |
|---|---|---|
| Display door, medium temperature | DD, M | $0.04 \times A_{dd} + 0.41$ |
| Display door, low temperature | DD, L | $0.15 \times A_{dd} + 0.29$ |

a $A_{dd}$ is the surface area of the display door.

**Table C410.3.1(2)**
**Walk-in Cooler and Freezer Nondisplay Doors Efficiency Requirements**

| Class Description | Class | Maximum Energy Consumption (kWh/day)[a] |
|---|---|---|
| Passage door, medium temperature | PD, M | $0.05 \times A_{nd} + 1.7$ |
| Passage door, low temperature | PD, L | $0.14 \times A_{nd} + 4.8$ |
| Freight door, medium temperature | FD, M | $0.04 \times A_{nd} + 1.9$ |
| Freight door, low temperature | FD, L | $0.12 \times A_{nd} + 5.6$ |

a $A_{nd}$ is the surface area of the display door.

**Table C410.3.1(3)**
**Walk-in Cooler and Freezer Refrigeration Systems Efficiency Requirements**

| Class Description | Class | Minimum Annual Walk-in Energy Factor AWEF (Btu/hW-h) | Test Procedure |
|---|---|---|---|
| Dedicated condensing, medium temperature, indoor system | DC.M.I | 5.61 | AHRI 1250 |
| Dedicated condensing, medium temperature, outdoor system | DC.M.O | 7.60 | |
| Dedicated condensing, low temperature, indoor system, net capacity ($q_{net}$) < 6,500 Btu/h | DC.L.I, < 6,500 | $9.091 \times 10^{-5} \times q_{net} + 1.81$ | |
| Dedicated condensing, low temperature, indoor system, net capacity ($q_{net}$) ≥ 6,500 Btu/h | DC.L.I, ≥ 6,500 | 2.40 | |
| Dedicated condensing, low temperature, outdoor system, net capacity ($q_{net}$) < 6,500 Btu/h | DC.L.O, < 6,500 | $9.091 \times 10^{-5} \times q_{net} + 2.73$ | |
| Dedicated condensing, low temperature, outdoor system, net capacity ($q_{net}$) ≥ 6,500 Btu/h | DC.L.O, ≥ 6,500 | 3.15 | |
| Unit cooler, medium | UC.M | 9.00 | |
| Unit cooler, low temperature, net capacity ($q_{net}$) < 15,500 Btu/h | UC.L, < 15,500 | $9.091 \times 10^{-5} \times q_{net} + 2.73$ | |
| Unit cooler, low temperature, net capacity ($q_{net}$) ≥ 15,500 Btu/h | UC.L, ≥ 15,500 | 4.15 | |

**C410.4 Refrigerated case and walk-in display doors.** Lighting in glass doors in all *walk-in coolers* and *walk-in freezers* and all *refrigerated warehouse coolers* and *refrigerated warehouse freezers* shall comply with the following:

1. Time switch controls to turn off lights during nonbusiness hours. Timed overrides for display cases shall turn the lights on for up to 1 hour and shall automatically time out to turn the lights off.

2. Motion sensor controls on each display case section that reduce lighting power by at least 50 percent within 3 minutes after the area within the sensor range is vacated.

**C410.5 Refrigeration systems.** Refrigerated display cases, *walk-in coolers* or *walk-in freezers* that are served by remote compressors and remote condensers not located in a *condensing unit*, shall comply with Sections C410.5.1, C410.5.2, and C403.9.2.3.

**EXCEPTION:** Systems where the working fluid in the refrigeration cycle goes through both subcritical and supercritical states (transcritical) or that use ammonia refrigerant are exempt.

**C410.5.1 Condensers serving refrigeration systems.** Fan-powered condensers shall comply with the following:

1. The design *saturated condensing temperatures* for air-cooled condensers shall not exceed the design dry-bulb temperature plus 10°F (5.6°C) for *low-temperature refrigeration systems*, and the design dry-bulb temperature plus 15°F (8°C) for *medium temperature refrigeration systems* where the *saturated condensing temperature* for blend refrigerants shall be determined using the average of liquid and vapor temperatures as converted from the condenser drain pressure.
2. Condenser fan motors that are less than 1 hp (0.75 kW) shall use electronically commutated motors, permanent split-capacitor-type motors or 3-phase motors.
3. Condenser fans for air-cooled condensers, evaporatively cooled condensers, air- or water-cooled fluid coolers or cooling towers shall reduce fan motor demand to not more than 30 percent of design wattage at 50 percent of design air volume, and incorporate one of the following continuous variable speed fan control approaches:
    3.1. Refrigeration system condenser control for air-cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient dry-bulb temperature.
    3.2. Refrigeration system condenser control for evaporatively cooled condensers shall use variable setpoint control logic to reset the condensing temperature setpoint in response to ambient wet-bulb temperature.
4. Multiple fan condensers shall be controlled in unison.
5. The minimum condensing temperature setpoint shall be not greater than 70°F (21°C).

**C410.5.2 Compressor systems.** Refrigeration compressor systems shall comply with the following:

1. Compressors and multiple-compressor system suction groups shall include control systems that use floating suction pressure control logic to reset the target suction pressure temperature based on the temperature requirements of the attached refrigeration display cases or walk-ins.

    **EXCEPTION:** Controls are not required for the following:

    1. Single-compressor systems that do not have variable capacity capability.
    2. Suction groups that have a design saturated suction temperature of 30°F (-1.1°C) or higher, suction groups that comprise the high stage of a two-stage or cascade system, or suction groups that primarily serve chillers for secondary cooling fluids.
2. Liquid subcooling shall be provided for all low-temperature compressor systems with a design cooling capacity equal to or greater than 100,000 Btu/hr (29.3 kW) with a design-saturated suction temperature of -10°F (-23°C) or lower. The subcooled liquid temperature shall be controlled at a maximum temperature setpoint of 50°F (10°C) at the exit of the subcooler using either compressor economizer (interstage) ports or a separate compressor suction group operating at a saturated suction temperature of 18°F (-7.8°C) or higher.
    2.1. Insulation for liquid lines with a fluid operating temperature less than 60°F (15.6°C) shall comply with Table C403.2.10.
3. Compressors that incorporate internal or external crankcase heaters shall provide a means to cycle the heaters off during compressor operation.
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 use no more than 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.

**C410.6 Commissioning.** Refrigeration systems shall be commissioned in accordance with Section C408.

**EXCEPTION:** Self-contained units.

## SECTION C411
## RENEWABLE ENERGY

**C411.1 On-site renewable energy.** Each new building ((~~,~~)) or addition, larger than ((~~10,000~~)) 5,000 square feet of *gross conditioned floor area*, shall include a renewable energy generation system consisting of not less than 0.5 W/ft$^2$ or 1.7 Btu/ft$^2$ multiplied by the sum of the *gross conditioned floor area*.

**EXCEPTIONS:**

((~~1. Any building where more than 50 percent of the roof area is shaded from direct beam sunlight by natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.~~

~~2. Any building where more than 80 percent of the roof area is covered by any combination of equipment other than for on-site renewable energy systems, planters, vegetated space, skylights or occupied roof deck.~~

~~3. Buildings which can document they do not have adequate roof area to install the required on-site solar and that comply with Section C411.1.1 may install a lesser amount of on-site renewables but not zero.~~))

1. Where a building's net roof area is not large enough to accommodate the entire on-site renewable energy generation system required by this section, the portion of that system that cannot be accommodated within the net roof area is permitted to be provided by one of the following options:
   a. Additional efficiency credits in accordance with Section C411.1.1.
   b. Off-site renewable energy in accordance with Section C411.2.1, including the requirements of Sections C411.2 and C411.2.2.

   For the purposes of this exception, the net roof area excludes the following:
   a. Areas shaded by existing natural or built objects in accordance with Exception 1 of Section C411.3.
   b. Areas occupied by mechanical equipment, including adjacent equipment service areas required by manufacturer or by applicable code.
   c. Areas required by applicable codes to remain clear for egress, fire department access, or equipment access.
   d. Areas with slopes greater than 2:12.
   e. Planted or vegetated areas.
   f. Skylights.
   g. Occupied roof decks.
2. Reduced Building Performance Factor. For projects utilizing the Section C407 Total Building Performance compliance path the on-site renewable energy generation system is not required where the building performance factor (BPF) is not less than 3 percent lower than the maximum BPF permitted cumulatively by all other sections of this code.

**Example:** To use this exception, a building with a required BPF of 50 would be required to provide a BPF of (50 x 0.97 =) 48.5 instead.

   2.1. Where the BPF is not less than 1 percent lower than the BPF required cumulatively by other sections of this code, the size of the on-site renewable energy generation system is permitted to be reduced by 1/3.
   2.2. Where the BPF is not less than 2 percent lower than the BPF required cumulatively by other sections of this code, the size of the on-site renewable energy generation system is permitted to be reduced by 2/3.
3. Transfer to an *affordable housing* project. Where *approved* by SDCI, all or part of the required on-site renewable energy generation system is permitted to be replaced by construction of a system that is 50 percent of the required system size when located on an existing *affordable housing* project within the City of Seattle, or 75 percent of the required system size when located on a new construction *affordable housing* project within the City of Seattle. Documentation demonstrating that the renewable energy generation system has been installed on the *affordable housing* project site, the system is fully operational, and ownership has been transferred to the owner of the *affordable housing* project, must be submitted prior to issuance of the certificate of occupancy.

**SDCI Informative Note:** Option 3 will only be available if an *affordable housing* project is available to accept the renewable energy system. There is no assurance that such a project location will be available. It is the owner's responsibility to locate and coordinate with the *affordable housing* project, and to ensure that the installation is completed in a timely manner.

4. Transfer to a Washington State agency program. Where *approved* by SDCI, all or part of the required renewable energy generation system is permitted to be replaced by a contribution of $2.50 for each required watt of installed capacity, to a solar energy fund managed by a Washington State agency that will provide solar energy installations

for *affordable housing* projects. Documentation demonstrating that the contribution has been received by the state agency must be submitted prior to issuance of the certificate of occupancy.

**SDCI Informative Note:** Option 4 is available via the solar energy fund for *affordable housing* of the Washington State Housing Finance Commission. Contact: energy@wshfc.org.

5. *Affordable housing*. The on-site renewable energy generation system is not required for *affordable housing* projects.

**SDCI Informative Note:** Fire Department requirements for solar arrays are located in Section 1204 of the Seattle Fire Code.

**C411.1.1 Additional efficiency credits.** Buildings which qualify for ((~~one of the exceptions~~)) Exception 1 in Section C411.1 to omit installation of on-site renewable energy ((~~must~~)) are permitted to achieve ((~~an~~)) additional ((~~18~~)) efficiency package credits from Table C406.2(1) equal to five times the number of credits provided for compliance with the renewable energy measure detailed in Section C406.2.5, in lieu of installing the on-site renewable energy required by Section C411.1. The additional ((~~18~~)) credits ((~~can~~)) are permitted to be reduced based on a prorated fraction of renewable capacity that is installed on-site.

On-site renewable energy installations of lower than required capacity can be counted proportionally toward achievement of required or additional efficiency credits in Section C411.1.1 based on the capacity of renewable energy installed compared to the requirements of Section C411.1.

**C411.2 On-site and off-site renewable energy accounting.** Qualifying on-site and off-site renewable energy delivered or credited to the building project to comply with this code shall meet the requirements of this section. Renewable energy certificates for an on-site or off-site renewable energy system shall be retired on behalf of the building owner for a period of not less than 15 years and tracked in accordance with Section C411.2.3 and submitted to the code official ((~~as part of the permit application~~)) before the final inspection. Renewable energy certificates (RECs) themselves are not a qualifying type of off-site renewable energy system.

**C411.2.1 Qualifying types of off-site renewable energy systems.** The following are considered qualifying off-site renewable energy systems:

1. Self-generation (an off-site renewable energy system owned by the building project owner) systems complying with Section C411.2.2.
2. Community renewable energy facility systems complying with Section C411.2.2.
3. ((~~Purchase~~)) Renewable power purchase agreement (PPA) contracts complying with Section C411.2.2 and, where applicable, Section C411.2.3.
4. Each source of renewable energy delivered to or credited to the building project shall be connected to the Western Interconnection and energy or capacity multiplied by the factors in Table C411.2.1.

**Table C411.2.1**
**Multipliers for Renewable Energy Procurement Methods**

| Location | Renewable Energy Source | Renewable Energy Factor | | |
|---|---|---|---|---|
| | | In the state of Washington | Western Interconnected | In the states of Oregon or Idaho |
| On-site | On-site renewable energy system | 1 | NA | NA |
| Off-site | Directly owned off-site renewable energy system that begins operation after submission of the initial permit application | 0.95 | 0.75 | 0.85 |
| Off-site | Community renewable energy facility that begins operation after submission of the initial permit application | 0.95 | 0.75 | 0.85 |
| Off-site | Directly owned off-site renewable energy system that begins operation before submission of the initial permit application | 0.75 | 0.55 | 0.65 |
| Off-site | Community renewable energy facility that begins operation before submission of the initial permit application | 0.75 | 0.55 | 0.65 |
| Off-site | Renewable Power Purchase Agreement (PPA) | 0.75 | 0.55 | 0.65 |
| Off-site | *Renewable Energy Investment Fund* (REIF) | 0.95 | 0.75 | 0.85 |

**C411.2.2 Documentation requirements for off-site renewable energy systems.** Off-site renewable energy delivered or credited to the building project to comply with Section C407.3 item 2.2, or other requirements of this code, shall be subject to a legally binding contract to procure qualifying off-site renewable energy. Qualifying off-site renewable energy shall meet the following requirements:

1. Documentation of off-site renewable energy procurement shall be submitted to the *code official* before the final inspection.
2. The purchase contract shall have a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.
3. Records on renewable power purchased by the building owner from the off-site renewable energy generator that specifically assign the RECs to the building owner shall be retained or retired by the building owner on behalf of the entity demonstrating financial or operational control over the building seeking compliance to this standard and made available for inspection by the *code official* upon request.
4. Where multiple buildings in a building project are allocated energy procured by a contract subject to this section, the owner shall allocate for not less than 15 years the energy procured by the contract to the buildings in the building project. A plan on operation shall be developed which shall indicate how renewable energy produced from on-site or off-site systems that is not allocated before issuance of the certificate of occupancy will be allocated to new or existing buildings included in the building project.

**C411.2.3 Renewable energy certificate (REC) tracking.** For multitenant buildings where RECs are transferred to tenants, the plan for operation shall include procedures for tracking the quantity and vintage of RECs that are required to be retained and retired. The plan shall include provisions to transfer the RECs to building tenants, or to retire RECs on their behalf, in proportion to the gross conditioned and semi-heated floor area leased or rented. The plan shall include provisions to use a REC tracking system that meets the requirements of Section V.B of the Green-e Framework for Renewable Energy Certification. The plan shall describe how the building owner will procure alternative qualifying renewable energy in the case that the renewable energy producer ceases. The plan shall be submitted to the *code official* prior to the final inspection.

**C411.3 Solar readiness.** A solar zone shall be provided on buildings that are 20 stories or less in height above grade plan. The solar zone shall be located on the roof of the building or on another structure elsewhere on the site. The solar zone shall be in accordance with this section and the *International Fire Code*.

**EXCEPTION:** A solar zone is not required under the following conditions:

1. Where the solar exposure of the building's roof area is less than 75 percent of that of an unshaded area, as defined in Section ((~~C411.5~~)) C411.3.4, in the same location, as measured by one of the following:
   1.1. Incident solar radiation expressed in kWh/ft$^2$-yr using typical meteorological year (TMY) data.
   1.2. Annual sunlight exposure expressed in cumulative hours per year using TMY data.
   1.3. Shadow studies indicating that the roof area is more than 25 percent in shadow, on September 21st at 10 a.m., 11 a.m., 12 p.m., 1 p.m., and 2 p.m. solar time.
2. Buildings, building additions, changes in space conditioning or occupancy where the total floor area is equal to or less than 500 square feet.

**SDCI Informative Note:** Requirements for solar arrays are located in Section 1204 of the Seattle Fire Code.

**C411.3.1 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, mechanical equipment, mechanical equipment service clearances required by equipment manufacturer or by code, and planted areas.
2. 20 percent of electrical service size. The electrical service size is the rated capacity of the total of all electrical services to the building, and the required solar zone size shall be based upon 10 peak watts of photovoltaic per square foot.

**EXCEPTION:** Subject to the approval of the code official, buildings with extensive rooftop equipment that would make full compliance with this section impractical shall be permitted to reduce the size of the solar zone required by Section C411.3 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% × (10,000 SF roof area - 1,000 SF skylights)] = 3,600 SF; or
2. [400 Amp × 240 Volts × 20% / 10 watts per SF] = 1,920 SF

Therefore, a *solar zone* of 1,920 square feet is required.

**C411.3.2 Contiguous area.** The solar zone is permitted to be comprised of separated subzones. Each subzone shall be at least 5 feet wide in the narrowest dimension.

**C411.3.3 Obstructions.** The solar zone shall be free of pipes, vents, ducts, HVAC equipment, skylights and other obstructions, except those serving photovoltaic systems within the solar zone. The solar zone is permitted to be located above any such obstructions, provided that the racking for support of the future system is installed at the time of construction, the elevated solar zone does not shade other portions of the solar zone, and its height is permitted by the *International Building Code* and the Seattle Land Use Code. Photovoltaic or solar water heating systems are permitted to be installed within the solar zone.

**C411.3.4 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 degrees of true north.

**C411.3.5 Access.** Areas contiguous to the solar zone shall provide access pathways and provisions for emergency smoke ventilation as required by the *International Fire Code*.

**C411.3.6 Structural integrity.** The as-designed dead load and live load for the solar zone shall be clearly marked on the record drawings and shall accommodate future photovoltaic system arrays at an assumed dead load of 4 pounds per square foot in addition to other required live and dead loads. A location for future inverters shall be designated either within or adjacent to the solar zone, with a minimum area of 2 square feet for each 1000 square feet of solar zone area, and shall accommodate an assume dead load of 175 pounds per square foot. Where photovoltaic systems are installed in the solar zone, structural analysis shall be based upon calculated loads, not upon these assumed loads.

**C411.3.7 Photovoltaic interconnection.** A minimum 2-inch diameter roof penetration conduit shall be provided, with threaded caps above and below the roof deck and minimum R-10 insulation wrapping the lower portion, within each 2,500 square foot section of the required *solar zone* area. Interconnection of the future photovoltaic system shall be provided for at the main service panel, either ahead of the service disconnecting means or at the end of the bus opposite the service disconnecting means, in one of the following forms:

1. A space for the mounting of a future overcurrent device, sized to accommodate the largest standard rated overcurrent device that is less than 20 percent of the bus rating.
2. Lugs sized to accommodate conductors with an ampacity of at least 20 percent of the bus rating, to enable the mounting of an external overcurrent device for interconnection.

The electrical construction documents shall indicate all of the following:

1. Solar zone boundaries and access pathways.
2. Location for future inverters and metering equipment.
3. Route for future wiring between the photovoltaic panels and the inverter, and between the inverter and the main service panel.

## SECTION C412
## COMPRESSED AIR SYSTEMS

**C412.1 General.** All new *compressed air systems*, and all additions or alterations of *compressed air systems* where the total combined horsepower (hp) of the compressor(s) is 25 hp or more, shall meet the requirements of this section. These requirements apply to the compressors, related piping systems, and related controls that provide compressed air and do not apply to any equipment or controls that use or process the compressed air.

**EXCEPTION:** Medical gas compressed air systems in health care facilities.

**C412.2 Trim compressor and storage.** The compressed air system shall be equipped with an appropriately sized trim compressor and primary storage to provide acceptable performance across the range of the system and to avoid control gaps. The compressed air system shall comply with 1 or 2 below:

1. The *compressed air system* shall include one or more variable speed drive (VSD) compressors. For systems with more than one compressor, the total combined capacity of the VSD compressor(s) acting as trim compressors must be at least 1.25 times the *largest net capacity increment* between combinations of compressors. The *compressed air system* shall include *primary storage* of at least one gallon per actual cubic feet per minute (acfm) of the largest trim compressor; or
2. The *compressed air system* shall include a compressor or set of compressors with total effective trim capacity at least the size of the *largest net capacity increment* between combinations of compressors, or the size of the smallest compressor, whichever is larger. The total effective trim capacity of single compressor systems shall cover at least the range from 70 percent to 100 percent of rated capacity. The effective trim capacity of a compressor is the size of the continuous operational range where the specific power of the compressor (kW/100 acfm) is within 15 percent of the

# Chapter 5 [CE]
# EXISTING BUILDINGS

## SECTION C501
## GENERAL

**C501.1 Scope.** The provisions of this chapter shall control the *alteration, repair*, *addition* and change of occupancy of existing buildings and structures.

**C501.1.1 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. Unaltered portions of existing buildings used for residential purposes that received a certificate of occupancy at least three years prior to a permit application for residential uses shall not be required to comply with this code, except where required by other provisions of this code.

**C501.2 Compliance.** *Additions*, *alterations*, *repairs*, changes in space conditioning and changes of occupancy to, or relocation of, existing buildings and structures shall comply with Section C502, C503, C504, or C505 of this code, and with all applicable provisions in the *International Building Code*, *International Existing Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *Uniform Plumbing Code*, and ((~~NFPA 70~~)) the Seattle Electrical Code.

**C501.2.1 *U*-factor requirements for additions and alterations.** For existing building projects where an *addition* or *building envelope alteration area* is combined with existing-to-remain building areas to demonstrate compliance with this code as a whole building, the *U*-factors applied to existing-to-remain envelope assemblies shall be in accordance with record documents.

**EXCEPTION:** If accurate record documents are not available, *U*-factors for the existing envelope assemblies may be in accordance with the edition of the ((~~Washington State~~)) Seattle Energy Code that was in effect at the time the building was permitted, or as approved by the *code official*.

**C501.2.2 Calculations of mechanical heating and cooling loads for alterations.** For the installation of new or replacement mechanical equipment that serves existing building areas, design loads associated with heating, cooling and ventilation of the existing building areas served shall be determined in accordance with Section C403.1.2.

*R*-values and *U*-factors used to determine existing thermal envelope performance for the purpose of calculating design loads shall be in accordance with record documents or existing conditions.

**EXCEPTION:** If accurate record documents are not available, *R*-values and *U*-factors used to determine existing building thermal envelope performance may be in accordance with the edition of the ((~~Washington State~~)) Seattle Energy Code that was in effect at the time the building was permitted, or as *approved* by the *code official*.

**C501.3 Maintenance.** Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems which are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

**C501.4 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

**C501.5 ((~~Historic buildings~~)) Landmarks.** The *code official* may modify the specific requirements of this code for *landmarks* and require in lieu thereof alternate provisions 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.

((~~Provisions of this code relating to the construction, *repair*, *alteration*, restoration and movement of structures, and *change of occupancy* shall not be mandatory for historic buildings provided that a report has been submitted to the code official and signed by a registered design professional, or a representative of the state historic preservation office or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the building.~~))

**C501.6 Commissioning.** Existing building systems shall be commissioned in accordance with Section C408. For the purposes of meeting the commissioning thresholds in Section C408.1, only the new and altered system capacities are considered when determining whether the project is exempt from some portion of the commissioning process.

## SECTION C502
## ADDITIONS

**C502.1 General.** *Additions* to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing building systems. An *addition* shall be deemed to comply with this code if the *addition* alone complies or if the existing building and *addition* comply with this code as a single building.

This allowance applies to prescriptive compliance in accordance with Section C502.2 or total building performance in accordance with Section C407.

**C502.1.1 Additional energy efficiency credits.** Additions shall comply with Section C406.1. The addition shall be deemed to comply with this section if the addition alone complies or if the addition area is combined with existing building areas to demonstrate compliance with an additional efficiency credit.

**Exception:** *Additions* smaller than 500 square feet of *conditioned floor area* are not required to comply with Section C406.

**C502.1.2 Renewable energy.** Additions shall comply with Section C411. The addition shall be deemed to comply with this section if the addition alone complies or if the addition area is combined with existing building areas to demonstrate compliance with the requirements for on-site renewable energy or solar readiness, as applicable.

**C502.2 Prescriptive compliance.** *Additions* shall comply with Sections ((~~C502.3 through C502.8~~)) C502.2.1 through C502.2.8.

**C502.2.1 Vertical fenestration.** *Additions* with *vertical fenestration* that results in a total building vertical fenestration area less than or equal to that specified in Section C402.4.1 shall comply with Section C402.4. *Additions* with *vertical fenestration* that results in a total building *vertical fenestration area* greater than that specified in Section C402.4.1 shall comply with one of the following:

1. Component performance alternative with target area adjustment per Section C402.1.5 for the *addition* area of the building only.
2. Existing building and *addition* area are combined to demonstrate compliance with the component performance alternative for the whole building.
3. Total building performance in accordance with Section C407 for the *addition* area of the building only.
4. Total building performance for the whole building.

**C502.2.2 Skylights.** *Additions* with *skylights* shall comply with the following:

1. Where an *addition* with skylight area results in a total building skylight area less than or equal to the maximum allowed by Section C402.4.1, the *addition* shall comply with Section C402.4.
2. Where an *addition* with skylight area results in a total building skylight area greater than the maximum allowed by Section C402.4.1 (regardless of the ratio prior to the *addition*), the *addition* shall comply with one of the following:
   - 2.1. Component performance alternative with target area adjustment per Section C402.1.5 for the addition area of the building only.
   - 2.2. Existing building and addition area are combined to demonstrate compliance with the component performance alternative for the whole building. *U*-factors applied to existing envelope assemblies in the UA calculation shall comply with Section C501.2.1.
   - 2.3. Total building performance in accordance with Section C407 for the addition area of the building only.
   - 2.4. Total building performance for the whole building.

**C502.2.3 (Reserved)**

**C502.2.4 Building mechanical systems.** New mechanical systems and equipment serving the building heating, cooling or ventilation needs, that are installed as a part of the *addition* shall comply with Sections C403, C408.2, ((~~C409.5~~)) C506.1, and C501.6.

**C502.2.5 Service water heating systems.** New service water-heating systems and equipment that are installed as a part of the *addition* shall comply with Sections C404, C408.3, ((~~C409.5~~)) C506.1, and C501.6.

**C502.2.6 Pools and permanent spas.** Systems and equipment serving new pools and permanent spas that are installed as a part of the *addition* shall comply with Sections C404.11, C408.3, ((~~C409.5~~)) C506.1, and C501.6.

**C502.2.7 Electrical power and lighting systems and motors.** New electrical power and lighting systems and motors that are installed as a part of the *addition* shall comply with Sections C405, C408.4, ((~~C409.5~~)) C506.1, and C501.6.

**C502.2.7.1 Interior lighting power.** The total interior lighting power for the addition shall comply with Section C405.4.2 for the addition alone, or the existing building and the addition shall comply as a single building.

**C502.2.7.2 Exterior lighting power.** The total exterior lighting power for the addition shall comply with Section C405.5.2 for the addition alone, or the existing building and the addition shall comply as a single building.

**C502.2.8 Refrigeration systems.** New refrigerated spaces and refrigeration systems and equipment that are installed as a part of the *addition* shall comply with Sections C408.7, ((~~C409.5~~)) C506.1, C410, and C501.6.

**C502.3 Building envelope.** Additions shall comply with Sections C402.1 through C402.5, C502.3.1, and C502.3.2.

**EXCEPTION:** Air leakage testing is not required for additions smaller than 500 square feet.

**C502.3.1 Vertical fenestration.** Additions with *vertical fenestration* shall comply with the following:

1. Where an *addition* with *vertical fenestration* area results in a total building *vertical fenestration* area less than or equal to the maximum allowed by Section C402.4.1, the addition shall comply with Section C402.4.
2. Where an *addition* with *vertical fenestration* area results in a total building vertical fenestration area greater than the maximum allowed by Section C402.4.1 (regardless of the ratio prior to the *addition*), the *addition* shall comply with one of the following:
   2.1. Component performance alternative with target area adjustment per Section C402.1.5 for the addition area of the building only.
   2.2. Existing building and addition area are combined to demonstrate compliance with the component performance alternative for the whole building. *U*-factors applied to existing envelope assemblies in the UA calculation shall comply with Section C501.2.1.
   2.3. Total building performance in accordance with Section C407 for the addition area of the building only.
   2.4. Total building performance for the whole building.

## SECTION C503
## ALTERATIONS

**C503.1 General.** Alterations to any building or structure shall comply with the requirements of Section C503 and the code for new construction. Alterations to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this code. Alterations shall be such that the existing building or structure is no less conforming with the provisions of this code than the existing building or structure was prior to the alteration. The additional energy efficiency credit requirements in Section C406.1 and the renewable energy requirements in Section C411 do not apply to alterations, except substantial alterations or change of space conditioning, occupancy, or use, in compliance with Section C505. Substantial alterations and *repairs* shall comply with Section C503.9.

**EXCEPTION:** The following alterations need not comply with the requirements for new construction provided the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Surface applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided the code does not require the glazing fenestration to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are insulated to full depth with insulation having a minimum nominal value of R-3.0 per inch installed per Section C402.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. *Roof recover*.
6. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.
7. Replacement of existing doors that separate conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided however that an existing vestibule that separates a conditioned space from the exterior shall not be removed.

**C503.2 Reserved.**

**C503.3 Building envelope.** New building envelope assemblies that are part of the alteration shall comply with Sections C402.1 through C402.5 and Sections C503.3.1 through C503.3.3. Where an opaque envelope assembly is altered or replaced, the new assembly shall in no case have a higher overall U-value than the existing.

**EXCEPTION:** Air leakage testing is not required for alterations and repairs, unless the project has been defined as a substantial alteration according to Section C503.9, or includes a change in space conditioning according to Section ((~~C503.2~~)) C505.2 or a change of occupancy or use according to Section ((~~C505.1~~)) C505.3.

**C503.3.1 Roof replacement.** *Roof replacements* shall comply with Table C402.1.3 or C402.1.4 where the existing roof assembly is part of the *building thermal envelope* and contains no insulation or the insulation is located entirely above the roof deck. In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.

**C503.3.2 Vertical fenestration.** Alterations that include the addition of new vertical fenestration area shall comply with the following:

1. Where the addition of new *vertical fenestration* ((~~that~~)) area results in a total building vertical fenestration area less than or equal to the maximum allowed by Section C402.4.1, the alteration shall comply with Section C402.4.
2. Where the addition of new *vertical fenestration* area ((~~result~~)) results in a total building *vertical fenestration* area greater than the maximum allowed by Section C402.4.1 (regardless of the ratio prior to the addition), the alteration shall comply with one of the following:
    2.1. Vertical fenestration alternate in accordance with Section ((~~C402.1.3~~)) C402.4.1.1 for the new vertical fenestration added, where the calculation of vertical fenestration area and gross *above-grade wall* area shall include either the entire building or, where *approved*, only those areas of the building involved in the *alteration*.
    2.2. ((~~Vertical fenestration alternate in accordance with Section C402.4.1.1 for the area adjacent to the new vertical fenestration added.~~)) (Reserved)
    2.3. Existing building and alteration areas are combined to demonstrate compliance with the component performance alternate in accordance with Section C402.1.5 for the whole building. *U*-factors applied to existing envelope assemblies in the UA calculation shall comply with Section C501.2.1. The Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.
    2.4. Total building performance in accordance with Section C407 for the whole building. The total annual ((~~carbon emissions from~~)) energy consumption of the proposed design is allowed to be up to 110 percent of the annual ((~~carbon emissions from~~)) energy consumption allowed in accordance with Section C407.3.
    2.5. The alteration does not increase the existing fenestration area.

**EXCEPTION:** Where *approved* by the *code official*, additional *fenestration* is permitted where sufficient envelope upgrades beyond those required by other sections of this code are included in the project so that the addition of new *vertical fenestration* does not cause an increase in the overall energy use of the building.

**C503.3.2.1 Replacement fenestration products.** Where some or all of an existing *fenestration* unit is replaced with a new *fenestration* product, including sash and glazing, the replacement *fenestration* unit shall meet the applicable requirements for *U*-factor and *SHGC* in Table C402.4. In addition, the area-weighted U-value of the new fenestration shall be equal to or lower than the U-value of the existing fenestration.

**EXCEPTION:** An area-weighted average of the *U*-factor of replacement fenestration products being installed in the building for each fenestration product category listed in Table C402.4 shall be permitted to satisfy the *U*-factor requirements for each fenestration product category listed in Table C402.4. Individual fenestration products from different product categories listed in Table C402.4 shall not be combined in calculating the area-weighted average *U*-factor.

**C503.3.3 Skylights.** Alterations that include the addition of new skylight area shall comply with the following:

1. Where the addition of new *skylight* area results in a total building skylight area less than or equal to the maximum allowed by Section C402.4.1, the alteration shall comply with Section C402.4.
2. Where the addition of new *skylight* area results in a total building skylight area greater than the maximum allowed by Section C402.4.1 (regardless of the ratio prior to the addition), the alteration shall comply with one of the following:
    2.1. Existing building and alteration area are combined to demonstrate compliance with the component performance alternative with target area adjustment in accordance with Section C402.1.5 for the whole building. *U*-factors applied to existing envelope assemblies in the UA calculation shall comply with Section C501.2.1. The Proposed Total UA is allowed to be up to 110 percent of the Allowed Total UA.
    2.2. Total building performance in accordance with Section C407 for the whole building. The annual ((~~carbon emissions from~~)) energy consumption of the proposed design is allowed to be up to 110 percent of the annual ((~~carbon emissions from~~)) energy consumption allowed in accordance with Section C407.3.

**EXCEPTION:** Additional envelope upgrades are included in the project so the addition of new skylights does not cause a reduction in overall building energy efficiency, as *approved* by the *code official*.

**C503.4 Building mechanical systems.** Components of existing mechanical systems that are altered or replaced shall comply with Section C403 or Section C407, unless specifically exempted in Section C503.4, and Sections C408.2, ((~~C409.5~~)) C506.1, C501.2.2, C501.6, and C503.4.2 through C503.4.6. Additions or alterations shall not be made to an existing mechanical system that will cause the existing system to become out of compliance.

**EXCEPTIONS:**

1. Existing mechanical systems are not required to be modified to comply with Section C403.3.5 where mechanical cooling capacity is not added to a system that did not have cooling capacity prior to the alteration.
2. Compliance with Section C403.1.4 is not required where the alteration does not include replacement of a heating appliance.
3. Alternate mechanical system designs that are not in full compliance with this code may be approved when the code official determines that existing building constraints including, but not limited to, available mechanical space, limitations of the existing structure, or proximity to adjacent air intakes or exhausts makes full compliance impractical. Alternate designs shall include additional energy saving strategies not prescriptively required by this code for the scope of the project including, but not limited to, demand control ventilation, energy recovery, or increased mechanical cooling or heating equipment efficiency above that required by Tables C403.3.2(1) through C403.3.2 (16).
4. Only those components of existing HVAC systems that are altered or replaced shall be required to comply with Section C403.8.1. Section C403.8.1 does not require the removal and replacement of existing system ductwork. Additional fan power allowances are available when determining the fan power budget (Fan $kW_{budget}$) as specified in Table C503.4. These values can be added to the fan power allowance values in Tables C403.8.1.1(1) and C403.8.1.1(2) when calculating a new Fan $kW_{budget}$ for the fan system being altered. The additional fan power allowance is not applicable to alterations that add or change passive components which do not increase the fan system static pressure.

**Table C503.4**
**Additional Fan Power Allowances (W/CFM)**

| Airflow | Multi-Zone VAV Systems[a] ≤5,000 cfm | Multi-Zone VAV Systems[a] >5,000 and ≤10,000 cfm | Multi-Zone VAV Systems[a] >10,000 cfm | All Other Fan Systems ≤5,000 cfm | All Other Fan Systems >5,000 and ≤10,000 cfm | All Other Fan Systems >10,000 cfm |
|---|---|---|---|---|---|---|
| Supply *Fan System* additional allowance | 0.135 | 0.114 | 0.105 | 0.139 | 0.120 | 0.107 |
| Supply *Fan System* additional allowance in unit with adapter curb | 0.033 | 0.033 | 0.043 | 0.000 | 0.000 | 0.000 |
| Exhaust/Relief/Return/Transfer Fan System additional allowance | 0.070 | 0.061 | 0.054 | 0.070 | 0.062 | 0.055 |
| Exhaust/Relief/Return/Transfer *Fan System* additional allowance with adapter curb | 0.016 | 0.017 | 0.220 | 0.000 | 0.000 | 0.000 |

a See definition of *FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV)*.

**C503.4.1 New building mechanical systems.** All new mechanical systems and equipment in existing buildings shall comply with Sections C403, C408.2, ((~~C409.5~~)) C506.1, and C501.6.

**C503.4.2 Addition of cooling capacity.** Where mechanical cooling is added to a space that was not previously cooled, the mechanical system shall comply with either Section C403.3.5 or C403.5.

**EXCEPTIONS:**

1. Qualifying small equipment: Economizers are not required for cooling units and split systems serving one zone with a total cooling capacity rated in accordance with Section C403.3.2 of less than 33,000 Btu/h (hereafter referred to as qualifying small systems) provided that these are high-efficiency cooling equipment with SEER and EER values more than 15 percent higher than minimum efficiencies listed in Tables C403.3.2 (1), (2), (4), (8), (9), and (14), 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 the building total air economizer capacity, whichever is greater.

   Notes and exclusions for Exception 1:

   1.1. The portion of the equipment serving Group R occupancies is not included in determining the total capacity of all units without economizers in a building.

   1.2. Redundant units are not counted in the capacity limitations.

1.3. This exception shall not be used for the initial tenant improvement of a shell-and-core building or space, or for Total Building Performance in accordance with Section C407.

1.4. This exception shall not be used for unitary cooling equipment installed outdoors or in a mechanical room adjacent to the outdoors.

2. Chilled water terminal units connected to systems with chilled water generation equipment with IPLV values more than 25 percent higher than minimum part load equipment efficiencies listed in Table C403.3.2 (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 systems without economizers shall not exceed ((~~480,000~~)) 72,000 Btu/h (141 kW) per building, or 20 percent of the building total air economizer capacity, whichever is greater.

Notes and exclusions for Exception 2:

2.1. The portion of the equipment serving Group R occupancy is not included in determining the total capacity of all units without economizers in a building.

2.2. This exception shall not be used for the initial tenant improvement of a shell-and-core building or space, or for total building performance in accordance with Section C407.

**C503.4.3 Alterations or replacement of existing cooling systems.** Alterations to, or replacement of, existing mechanical cooling systems shall not decrease the building total economizer capacity unless the system complies with either Section C403.3.5 or C403.5. System alterations or replacement shall comply with Table C503.4.3 when either the individual cooling unit capacity or the building total capacity of all cooling equipment without economizer does not comply with the exceptions in Section C403.5. Equipment replacements that include space heating shall also comply with Section C503.4.6.

**C503.4.3.1 Addition of new or replacement of existing air-cooled chiller systems.** Where one or more air-cooled chillers are added or replaced, and the existing HVAC heating equipment is included in one of the categories listed below and is fossil fuel–fired or electric resistance, the replacement cooling appliance shall be an electric heat pump system in compliance with Section C403.1.4, integrated with the existing HVAC heating system and configured to serve as the first stage of heating when conditions permit use of the fluid temperatures produced by the heat pump system, with the existing fossil fuel–fired or electric resistance HVAC heating equipment serving as supplemental heat. Additions, alterations, or replacements shall not be made to an existing HVAC heating system that will cause the system to become out of compliance.

**Exceptions:**

1. Exempt buildings and occupancies. The new heat pump is not required to serve as the first stage of heating if it serves any of the following building categories and the requirements of Section C503.4.6.2 are met.
   a. Affordable housing.
   b. Group I-1, I-2, and I-3 occupancies.
   c. Buildings with more than 50 percent of conditioned floor area occupied by organizations recognized as nonprofit by the State of Washington or by federal tax law.
   d. Buildings with no more than 20,000 square feet of conditioned floor area.
2. Exempt systems. Air-cooled chillers that serve dedicated server rooms, electronic equipment rooms, telecom switch rooms, or similar spaces that only require cooling and do not have any associated space heating equipment are not required to be replaced with heat pump systems. New heat pump systems are not required to serve as the first stage of heating if they serve any of the following system types, and if the requirements of Section C503.4.6.2 are met.
   a. Steam heating systems, including replacement of existing steam boilers with steam distribution piping to terminal units and replacement of the existing associated boiler feed equipment.
   b. Terminal unit equipment including but not limited to electric resistance VAV boxes, electric duct heaters, electric resistance fan coils, or electric resistance heaters.

**Table C503.4.3**
**Economizer Compliance Options for Mechanical Alterations**

| Unit Type | Option A<br>Any alteration with new or replacement equipment | Option B (alternate to A)<br>Replacement unit of the same type with the same or smaller output capacity | Option C (alternate to A)<br>Replacement unit of the same type with a larger output capacity | Option D (alternate to A)<br>New equipment added to existing system or replacement unit of a different type |
|---|---|---|---|---|
| 1. Packaged Units | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| 2. Split Systems | Efficiency: min. [a]<br>Economizer: C403.5[b] | For units ≤ 60,000 Btuh, comply with two of two measures:<br>1. Efficiency: + 10%[e]<br>2. Economizer: shall not decrease existing economizer capability | For units ≤ 60,000 Btuh replacing unit installed prior to 1991 comply with at least one of two measures:<br>1. Efficiency: + 10%[e]<br>2. Economizer: 50% [f] | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| | | For all other capacities:<br>Efficiency: min.[a]<br>Economizer: C403.5[b] | For all other capacities:<br>Efficiency: min.[a]<br>Economizer: C403.5[b] | |
| 3. Water Source Heat Pump | Efficiency: min. [a]<br>Economizer: C403.5[b] | For units ≤ 72,000 Btuh, comply with at least two of three measures:<br>1. Efficiency: +10%[e]<br>2. Flow control valve [g]<br>3. Economizer: 50% [f] | For units ≤ 72,000 Btuh, comply with at least three of three measures:<br>1. Efficiency: +10%[e]<br>2. Flow control valve [g]<br>3. Economizer: 50% [f] (except for certain pre-1991 systems [q]) | Efficiency: min. [a]<br>Economizer: C403.5[b] (except for certain pre-1991 systems [q]) |
| | | For all other capacities:<br>Efficiency: min.[a]<br>Economizer: C403.5[b] | For all other capacities:<br>Efficiency: min.[a]<br>Economizer: C403.5[b] | |
| 4. Water Economizer using Air-Cooled Heat Rejection Equipment (Dry Cooler) | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: + 5%[d]<br>Economizer: shall not decrease existing economizer capacity | Efficiency: min.[a]<br>Economizer: C403.5[b] | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| 5. Air-Handling Unit (including fan coil units) where the system has an air-cooled chiller | Efficiency: min. [a]<br>Economizer: C403.5[b] | Economizer: shall not decrease existing economizer capacity | Efficiency: min.[a]<br>Economizer: C403.5[b] (except for certain pre-1991 systems [q]) | Efficiency: min.[a]<br>Economizer: C403.5[b] (except for certain pre-1991 systems [q]) |
| 6. Air-Handling Unit (including fan coil units) and Water-cooled Process Equipment, where the system has a water-cooled chiller[10] | Efficiency: min. [a]<br>Economizer: C403.5[b] | Economizer: shall not decrease existing economizer capacity | Efficiency: min.[a]<br>Economizer: C403.5[b] (except for certain pre-1991 systems [q] and certain 1991-2016 systems [i]) | Efficiency: min. [a]<br>Economizer: C403.5[b] (except for certain pre-1991 systems [q] and certain 1991-2016 systems [i]) |
| 7. Cooling Tower | Efficiency: min. [a]<br>Economizer: C403.5[b] | No requirements | Efficiency: min.[a]<br>Economizer: C403.5[b] | Efficiency: min.[a]<br>Economizer: C403.5[b] |

**Table C503.4.3—continued**
**Economizer Compliance Options for Mechanical Alterations**

| Unit Type | Option A | Option B (alternate to A) | Option C (alternate to A) | Option D (alternate to A) |
|---|---|---|---|---|
| | 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 |
| 8. Air-Cooled Chiller | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: + 10%[k]<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency:<br>Comply with two of two measures:<br>1. + 10% [k,l] and<br>2. Multistage compressor(s)<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| 9. Water-Cooled Chiller | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency:<br>Comply with at least one of two measures:<br>1. Part load IPLV + 15%[n] or<br>2. Plate frame heat exchanger [o]<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency:<br>Comply with two of two measures:<br>1. Part load IPLV + 15% [n]<br>2. Plate-frame heat exchanger [o]<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| 10. Package Terminal Air Conditioner | Efficiency: min. [a]<br>Economizer: C403.5[b] | Efficiency: + 5%[a]<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency: + 5%[a]<br>Economizer: shall not decrease existing econo-mizer capacity | Efficiency: min. [a]<br>Economizer: C403.5[b] |
| 11. Package Terminal Heat Pump | Efficiency: min. [a]<br>Economizer: C403.5[b] | Cooling efficiency: + 5%[d]<br>Heating efficiency: + 10%[e]<br>Shall not decrease existing economizer capacity | Cooling efficiency: + 5%[d]<br>Heating efficiency: + 10%[e]<br>Shall not decrease existing economizer capacity | Efficiency: min. [a]<br>Economizer: C403.5[b] |

a Minimum equipment efficiency shall comply with Section C403.3.2 and the tables in Section C403.3.2.

b All separate new equipment and replacement equipment shall have air economizer complying with Section C403.5 including both the individual unit size limits and the total building capacity limits on units without economizer. It is acceptable to comply using one of the exceptions to Section C403.5.

c Reserved.

d Equipment shall have a capacity-weighted average cooling system efficiency that is 5% better than the requirements in the tables in Section C403.3.2 (1.05 × values in the tables.

e Equipment shall have a capacity-weighted average cooling system efficiency that is 10% better than the requirements in the tables in Section C403.3.2 (1.10 × values in the tables.

f Minimum of 50% air economizer that is ducted in a fully enclosed path directly to every heat pump unit in each zone, except that ducts may terminate within 12 inches of the intake to an HVAC unit provided that they are physically fastened so that the outside air duct is directed into the unit intake. If this is an increase in the amount of outside air supplied to this unit, the outside air supply system shall be configured to provide this additional outside air and be equipped with economizer control.

g Water-source heat pump systems shall have a flow control valve to eliminate flow through the heat pumps that are not in operation and variable speed pumping control complying with Section C403.4.3 for that heat pump.

- When the total capacity of all units with flow control valves exceeds 15% of the total system capacity, a variable frequency drive shall be installed on the main loop pump.
- As an alternate to this requirement, the capacity-weighted average cooling system efficiency shall be 5% better than the requirements in footnote e for water-source heat pumps (i.e., a minimum of 15% greater than the requirements in Table C403.3.2 (14)).

h Water economizer equipment shall have a capacity-weighted average cooling system efficiency that is 10% better than the requirements in Tables C403.3.2 (7), C403.3.2(10), and C403.3.2 (16) (1.10 × values in Tables C403.3.2 (7), C403.3.2(10), and C403.3.2 (16)).

i Air economizer is not required for systems installed with water economizer plate and frame heat exchanger complying with previous codes between 1991 and June 2016, provided that the total fan coil load does not exceed the existing or added capacity of the heat exchangers.

j For water-cooled process equipment where the manufacturers specifications require colder temperatures than available with waterside economizer, that portion of the load is exempt from the economizer requirements.

k The air-cooled chiller shall have an IPLV efficiency that is a minimum of 10% greater than the IPLV requirements in EER in Table C403.3.2 (3) (1.10 × IPLV values in EER in Table C403.3.2 (3)).

l The air-cooled chiller shall be multistage with a minimum of two compressors.

m ((~~The water-cooled chiller shall have full load and part load IPLV efficiency that is a minimum of 5% greater than the IPLV requirements in Table C403.3.2(3).~~))

n The water-cooled chiller shall have an IPLV value that is a minimum of 15% lower than the IPLV requirements in Table C403.3.2(3) (0.85 × IPLV values in Table C403.3.2(3)). Water-cooled centrifugal chillers designed for nonstandard conditions shall have an NPLV value that is at least 15% lower than the adjusted maximum NPLV rating in kW per ton defined in Section C403.3.2.3 (0.85 × NPLV).

o Economizer cooling shall be provided by adding a plate-frame heat exchanger on the waterside with a capacity that is a minimum of 20% of the chiller capacity at standard AHRI rating conditions.

p Reserved.

q Systems installed prior to 1991 without fully utilized capacity are allowed to comply with Option B, provided that the individual unit cooling capacity does not exceed 90,000 Btuh.

**C503.4.4 Controls for cooling equipment replacement.** When space cooling equipment is replaced, controls shall comply with all requirements under Section C403.3.5 and related subsections, and Section C403.5.1 for integrated economizer control.

**C503.4.5 Mechanical equipment relocation.** Existing equipment currently in use may be relocated within the same floor or same tenant space if removed and reinstalled within the same permit.

((~~**C503.4.6 Addition or replacement of heating appliances.** Where a mechanical heating appliance is added or replaced, the added or replaced appliances shall comply with Section C403.1.4 or with an alternate compliance option in Table C503.4.6. Where use of heat pump equipment for space heating is required by this section, it is permissible to utilize the Fossil Fuel Compliance Path in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.~~

~~**EXCEPTIONS:**~~

1. ~~Terminal unit equipment including, but not limited to, hydronic VAV boxes, electric resistance VAV boxes, electric duct heaters, water source heat pumps, fan coils, or VRF indoor units that are served by an unaltered central system.~~
2. ~~Air handling equipment with hydronic coils~~
3. ~~Air handling equipment designed for 100 percent outdoor air that is not subject to the requirements in Section C403.3.5 or that qualifies for an exception to Section C403.3.5.~~
4. ~~Replacement of existing oil-fired boilers.~~
5. ~~Replacement of existing steam boilers with steam distribution to terminal units and the associated boiler feed equipment.~~
6. ~~Where compliance with Section C403.1.4 would trigger an unplanned utility electrical service upgrade based on the NEC 220.87 method for determining existing loads.~~
7. ~~Replacement of heating equipment with equipment that is the same type and where the rated capacity of the new equipment does not exceed the rated capacity of the existing equipment.~~))

**C503.4.6 Addition or replacement of HVAC heating appliances.** New HVAC heating systems shall comply with Section C403.1.4. Where one or more HVAC mechanical heating appliances are added or replaced, the added or replaced appliances shall comply with Section C401.3, Section C403.1.4, Section C407, or with an alternate compliance option in Table C503.4.6, and in all cases with Sections C501.6 and C506.1. When complying with the alternate compliance option in Table C503.4.6, added or replaced HVAC heating appliances must select HVAC heating appliances from one of the Proposed Heating Type Options and the applicable Heating Efficiency Tables. Additions, alterations, or replacements shall not be made to an existing HVAC heating system that will cause the existing system to become out of compliance. Where use of heat pump equipment for space heating is required by this section, it is permissible to utilize the Fossil Fuel Compliance Path in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.

**EXCEPTIONS:**

1. Exempt buildings and occupancies. Replacement heating equipment serving any of the following building categories is permitted to use the same fuel type as the existing equipment, provided the replacement equipment complies with the minimum efficiency in Table C503.4.6 and the same or lower capacity than the existing, and that the requirements of Section C503.4.6.2 are met.
   1. *Affordable housing*.
   2. Group I-1, I-2, and I-3 occupancies.
   3. Buildings with more than 50 percent of conditioned floor area occupied by organizations recognized as nonprofit by the State of Washington or by federal tax law.
   4. Buildings with no more than 20,000 square feet of conditioned floor area.
2. Retention of portion of existing system capacity. For buildings not exempted by Exception 1 above, a maximum of 50 percent of the existing fossil fuel or electric resistance heating capacity is permitted to be retained or replaced to serve as supplemental heat for the new heat pump heating system, provided that the supplemental heat is controlled to be used only when the heat pump system capacity is insufficient to meet the load, in compli-

ance with the applicable Exception 5, 6, or 7 to Section C403.1.4, and that the requirements of Section C503.4.6.2 are met. Where an alteration replaces less than 50 percent of the existing fossil fuel or electric resistance heating capacity, the remaining heating appliances are permitted to be retained. Where the alteration project decreases the peak heating load, the fossil fuel or electric resistance heating capacity shall be limited to 50 percent of the calculated peak heating load. The replacement equipment shall comply with the minimum efficiency in Table C503.4.6.

3. Temporary replacement of failing equipment. Temporary like-for-like replacement of one or more heating appliances, in excess of the 50 percent capacity permitted by Exception 2 above, is permitted where those appliances require immediate replacement, and where no other work on the HVAC system is planned. When using this exception, it is acceptable to replace a single appliance with two or more smaller appliances, provided the total capacity is not greater than that of the original appliance. In addition, the requirements of Section C503.4.6.2 shall be met, and the applicant shall ensure completion of the required heat pump system in compliance with one of the following options.
    a. SDCI will issue a temporary certificate of occupancy (TCO), which will remain in force until the heat pump heating system is installed and the final inspection of the system has been completed.
    b. Applicant shall post a performance bond in the amount of the full estimated cost of installation of the required heat pump system, to ensure completion of the heat pump system within 48 months.
4. Utility service upgrade. Compliance with Section C403.1.4 is not required where the requirements of Section C503.4.6.2 are met, and where such compliance would trigger an unplanned utility electrical service upgrade, based on the Seattle Electrical Code Section 220.87 method for determining existing loads, where one or more of the following is required:
    a. A new utility transformer vault located in the existing building or on the site, or an enlargement of the floor area of such a vault.
    b. Trenching across the vehicle lanes of a public way.
    c. The estimated construction cost for the required electrical service enlargement exceeds 50 percent of the project valuation for the remainder of the work, as determined in accordance with the *fee subtitle*. Construction cost shall be documented by an AACE Level 3 or equivalent cost estimate, including required demolition, construction, site work, and utility fees.

    The replacement equipment shall comply with the minimum efficiency in Table C503.4.6.
5. Exempt equipment. Alterations to the following equipment types are not required to comply with this section.
    a. Terminal unit equipment including but not limited to hydronic VAV terminal units, electric resistance VAV boxes, electric duct heaters, water source heat pumps, fan coils, or VRF indoor units, except such modifications to terminal equipment with hydronic heating coils as are required to accommodate lower-temperature fluids circulated from new central heat pump systems in accordance with Section C403.3.8.2.
    b. Air handling equipment with hydronic heating coils, except such modifications to the air handling equipment as are required to accommodate lower-temperature fluids circulated from central heat pump systems in accordance with Section C403.3.8.2.
    c. Replacement of existing steam boilers with steam distribution piping to terminal units and replacement of the existing associated boiler feed equipment.

**C503.4.6.1 Hydronic system alteration supply water temperature.** Hydronic heating coils and appliances subject to Section C503.4.5 or Section C503.4.6 shall comply with Section C403.3.8.2.

**C503.4.6.2 Future decarbonization plan.** For buildings with more than 20,000 square feet of conditioned space, a schematic-level design of a heat pump system to replace the existing system shall be prepared by a professional engineer and submitted to SDCI. The professional engineer must be identified on the schematic design documents, but the engineer's signature and date is not required, and no party is obligated to provide any further development of the schematic design. Documents submitted with the schematic design must include:

1. Completed SDCI decarbonization planning form, available on the SDCI website.
2. Mechanical and electrical one-line system diagrams, showing only the impacted portions of systems.
3. Equipment sized and laid out to scale on plans of the existing facility. Only the impacted areas need be depicted, at a simple schematic level of detail.
4. Required louvers, ducts, and air handling equipment.
5. Required structural modifications.
6. Required partitions, doors, and other architectural modifications.

7. Required electrical infrastructure, including any electrical service upgrade and vault.
8. Schematic-level cost estimate, AACE Class 5, or equivalent, including separate line items for structural, mechanical, electrical, architectural, and utility costs.
9. Applicable compliance dates for Washington State Clean Buildings Performance Standards and Seattle Building Emissions Performance Standards (BEPS) with maximum allowable energy use index (EUI) and carbon emissions.

**Table C503.4.6**
**Compliance Options for ((~~Mechanical~~)) HVAC Heating Equipment Alterations**

| | Proposed Heating Equipment Type[a] | Heating Efficiency Table Reference | Alternate Compliance Options to Section C403.1.4 |
|---|---|---|---|
| 1 | Air-Cooled Unitary Heat Pumps | Table C403.3.2(2) | 1. Compliance with C403.1.4, except heat pump rated capacity in accordance with Section C403.1.4 exception 5d is permitted to be sized equal to the supplemental internal resistance heating capacity in Climate Zone 4 or 5[c]<br>2. Compliance with C403.1.4, except electric resistance mixed air preheat is permissible[c] |
| 2 | Packaged terminal, single-package vertical, and room air-conditioner heat pumps | Table C403.3.2(4) | 1. Compliance with C403.1.4, except heat pump rated capacity in accordance with Section C403.1.4 Exception 5d is permitted to be sized equal to the supplemental internal resistance heating capacity in Climate Zone 4 or 5 |
| 3 | Furnaces, duct furnaces, and unit heaters | Table C403.3.2(5) | 1. Permitted only when qualifying for and complying with Section C503.4.6 Exceptions 1, 2, 3 or 4<br>2. Efficiency: ((~~+10%~~)) +5%[b] |
| 4 | Gas-fired hot water boilers | Table C403.3.2(6) | 1. Permitted only when qualifying for and complying with Section C503.4.6 Exceptions 1, 2, 3 or 4<br>2. Efficiency: +5%[b] |
| 5 | Variable refrigerant flow air-to-air and applied heat pumps | Table C403.3.2(9) | No alternate compliance option |
| 6 | DX-DOAS equipment | Table C403.3.2(12) and Table C403.3.2(13) | 1. DX-DOAS is provided with heat recovery if not required by C403.3.5.1. |
| 7 | Water-source heat pumps | Table C403.3.2(14) | No alternate compliance option |

a Includes replacement of equipment with a unit that is the same type or higher efficiency and the same or lower capacity, or a replacement of one equipment type with a different equipment type.

b Equipment shall have a capacity-weighted average heating system efficiency that is 5 percent better than that shown in the reference table (1.05 x values in reference table).

c Option 1 and Option 2 can be combined.

**C503.5 New Service water heating equipment.** All new service water heating systems shall comply with Section C404.

**C503.5.1 Addition or replacement of service water heating equipment.** All existing service hot water systems, equipment, and components of existing systems that are altered or replaced shall comply with Section C404 or Section C407 ((~~or Sections C404, C408.3, C409.5~~)) and in all cases with C506.1, and C501.6. Additions or alterations shall not be made to an existing service water heating system that will cause the existing system to become out of compliance. Where use of heat pump equipment for space heating is required by this section, it is permissible to utilize the Fossil Fuel Compliance Path in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.

**EXCEPTIONS:** ((~~The following equipment is not required to comply with Section C404.2.1~~))

1. ((~~Reserved.~~)) Utility service upgrade. Compliance with Section C403.1.4 is not required where the requirements of Section C503.4.6.2 are met, and where such compliance would trigger an unplanned utility electrical service upgrade, based on the Seattle Electrical Code Section 220.87 method for determining existing loads, where one or more of the following is required:
   a. A new utility transformer vault located in the existing building or on the site, or an enlargement of the floor area of such a vault.
   b. Trenching across the vehicle lanes of a public way.
   c. The estimated construction cost for the required electrical service enlargement exceeds 50 percent of the project valuation for the remainder of the work, as determined in accordance with the *fee subtitle*. Construction cost shall be documented by an AACE Level 3 or equivalent cost estimate, including required demolition, construction, site work, and utility fees.

The replacement equipment shall comply with the minimum efficiency in Table C503.4.6.

2. Exempt Systems. Replacement of any of the following water heater appliances is not required to comply with this section or with Section C404.2.1:
   2.1. Electric water heaters with an input of ((~~12~~)) 24 kW or less.
   2.2. Gas storage water heaters with an input of 75,000 Btu/h or less.
   2.3. Gas instantaneous water heaters with an input of 200,000 Btu/h or less and 2 gallons or less of storage.
   2.4. Replacement of existing steam boilers with steam distribution piping to terminal units and replacement of the existing associated boiler feed equipment.
3. (Reserved)
4. Exempt buildings. Replacement service water heating equipment for the following buildings is permitted to use the same fuel type as the existing equipment, provided the new equipment has no lower efficiency and no higher capacity than the existing, and that the requirements of Section C503.4.6.2 are met.
   a. *Affordable housing*.
   b. Group I-1, I-2, or I-3 occupancies.
   c. Buildings with more than 50 percent of conditioned floor area occupied by organizations recognized as nonprofit by the State of Washington or by federal tax law.
   d. Buildings smaller than 20,000 square feet.
5. Retention of portion of existing system capacity. A maximum of 50 percent of the existing central fossil fuel or electric resistance water heating capacity is permitted to be provided as supplemental heat for the new heat pump water heating system, provided that the supplemental heat is controlled to be used only when the heat pump system capacity is insufficient to meet the load, in compliance with Section C404.2.1.4, and that the requirements of Section C503.4.6.2 are met. Where an alteration replaces less than 50 percent of the existing fossil fuel or electric resistance service water heating capacity, the remaining service water heating appliances are permitted to be retained. Where the alteration project decreases the peak service water heating load, the fossil fuel or electric resistance heating capacity shall be limited to 50 percent of the calculated peak heating load.
6. Temporary replacement of failing equipment. Temporary like-for-like replacement of one or more service water heating appliances, in excess of the 50 percent capacity permitted by Exception 5 above, is permitted where those appliances require immediate replacement, and where no other work on the service water heating system is planned. When using this exception, it is acceptable to replace a single appliance with two or more smaller appliances, provided the total capacity is not greater than that of the original appliance. In addition, the requirements of Section C503.4.6.2 shall be met, and the applicant shall ensure completion of the required heat pump water heating system in compliance with one of the following options.
   a. SDCI will issue a temporary certificate of occupancy (TCO), which will remain in force until the heat pump water heating system is installed and the final inspection of the system has been completed.
   b. Applicant shall post a performance bond in the amount of the full estimated cost of installation of the required heat pump water heating system, to ensure completion of the system within 48 months.

**C503.6 Pools and permanent spas.** All new systems and equipment serving pools and permanent spas and components of existing systems that are altered or replaced, shall comply with Sections C404.11, C408.3, ((~~C409.5~~)) C506.1, and C501.6. Additions or alterations shall not be made to an existing system serving a pool or spa that will cause the existing system to become out of compliance.

**C503.7 Electrical power and lighting systems and motors.** Alterations or the addition of lighting, receptacles and motors shall comply with Sections C503.7.1 through C503.7.7. Additions or alterations shall not be made to an existing lighting or electrical system that will cause the existing system to become out of compliance.

**C503.7.1 New lighting ((~~systems and~~)) system controls.** All new interior and exterior lighting systems within an existing building site shall be provided with lighting controls in accordance with Section C405.2 and shall comply with C408.4, ((~~C409.5~~)) C506.1, and C501.6.

**C503.7.2 Luminaire additions and alterations.** Alterations that add or replace 20 percent or more of the luminaires, or of the lamps plus ballasts alone, in a space enclosed by walls or ceiling-height partitions, replace 20 percent or more of parking garage luminaires, or replace 20 percent or more of the total installed wattage of exterior luminaires shall comply with Sections C405.4 and C405.5. Exterior power allowance shall be determined using the specific area allowances for the areas altered and shall not include the base site allowance. Where less than 20 percent of the fixtures in an interior space enclosed by walls or ceiling-height partitions or in a parking garage are added or replaced, or less than 20 percent of the installed exterior wattage is replaced, the installed lighting wattage shall be maintained or reduced.

**C503.7.3 Rewiring and recircuiting.** Where new wiring is being installed to serve added fixtures and/or fixtures are being relocated to a new circuit, lighting controls shall comply with all applicable requirements in accordance with Sections C405.2.1, C405.2.3, C405.2.4, C405.2.5, C405.2.6, C405.2.7, C405.2.8, C408.4, and C501.6.

**C503.7.4 New or moved lighting panel.** Where a new lighting panel (or a moved lighting panel) with all new raceway and conductor wiring from the panel to the fixtures is being installed, lighting controls shall also comply with, in addition to the requirements of Section C503.7.3, all ((~~remaining~~)) requirements in Sections C405.2, C408.4, and C501.6.

**C503.7.5 Newly-created rooms.** Where new walls or ceiling-height partitions are added to an existing space and create a new enclosed space, but the lighting fixtures are not being changed, other than being relocated, the new enclosed space shall have lighting controls that comply with all applicable requirements in accordance with Sections C405.2.1, C405.2.2, C405.2.3, C405.2.4, C405.2.5, C405.2.6, C408.4 and C501.6.

**C503.7.6 Motors.** Motors that are altered or replaced shall comply with Section C405.8. In no case shall the energy efficiency of the building be decreased.

**C503.7.7 Controlled receptacles.** Where electric receptacles are added or replaced, controlled receptacles shall be provided in accordance with Section C405.10 and shall comply with Sections C408.4 and C501.6.f

**EXCEPTIONS:**

1. Where an alteration project impacts an area smaller than 5,000 square feet, controlled receptacles are not required.
2. Where existing systems furniture or partial-height relocatable office cubical partitions are reconfigured or relocated within the same area, controlled receptacles are not required in the existing systems furniture or office cubicle partitions.
3. Where new or altered receptacles meet ((~~the exception~~)) Exception 1 to Section C405.10, they are not required to be controlled receptacles or be located within 12 inches of noncontrolled receptacles.

**C503.8 Refrigeration systems.** Components of existing refrigeration systems that are altered or replaced shall comply with Sections C408.7, C410 and C501.6. Additions or alterations shall not be made to an existing refrigeration system that will cause the existing system to become out of compliance. All new refrigerated spaces and refrigeration systems and equipment in existing buildings, including new refrigerated display cases, shall comply with Sections C408.7, ((~~C409.5~~)) C506.1, C410 and C501.6.

**C503.9 Substantial alterations or repairs.** In addition to meeting the requirements of this code, any building or structure to which substantial alterations or repairs are made shall comply with the requirements of this section. Compliance with Sections C502, C503, and C504 is not required.

**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 C503.9.3 is permitted to be increased in proportion to the additional energy use required for preservation 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.

**C503.9.1 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*.

**SDCI Informative Note.** Alterations that convert HVAC heating systems, water heating systems, or both from fossil fuel or electric resistance to heat pump systems, and where the only additional alterations provide necessary electrical power, structural support, or air circulation for the heat pump system, might in certain cases not be classified as substantial alterations. Consult with your SDCI Building Code reviewer, and see additional guidance in SDCI Tip 314.

**SDCI Informative Note:** Definitions 1, 2 and 4 of "substantial alterations or repairs" in the Seattle Existing Building Code are as follows:

1. Repair of a building with a damage ratio 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.

**C503.9.2 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 at the pre-submittal conference.

**C503.9.3 Energy efficiency.** Buildings undergoing substantial alterations shall comply with Section C503.4.6 and one of the following:

1. Full code compliance. Fully comply with the requirements of this code for new construction, including Section C406.
2. Envelope thermal performance within 15 percent of code. Demonstrate that heat loss through the building envelope is no more than 15 percent greater than allowed by the Seattle Energy Code, using the Component Performance Building Envelope Option in Section C402.1.5, and meet all other prescriptive requirements of the Seattle Energy Code for new construction, including Section C406.
   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 whose original construction permits were applied for 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.
   2.2. Disproportionality. Where *approved* by the *code official*, the cost of required thermal improvements to the building envelope are not required to exceed 20 percent of the valuation of the substantial alterations project, determined in accordance with the Fee Subtitle, when using this envelope thermal performance compliance method. Envelope improvement costs shall be documented using standard cost estimating software and methodology.
3. Total building performance within 10 percent of code. Demonstrate that the Building Performance Factor is no more than 10 percent higher than that permitted by Table C407.3(2).

   **EXCEPTION:** The UxA calculation required by Section C407.3.1 is not required when using this option.
4. Operating energy alternative. The *code official* is permitted to allow calculated building performance factor 20 percent greater than the baseline building 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 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 C401.4.7 through C401.4.11, and to meet the requirements of Sections C401.4.12 through C401.4.14, substituting the energy consumption standard in option 4 of this Section C503.9.3 for the energy consumption targets set out in Section C401.4.2.
   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.

**C503.9.4 Impracticality.** In cases where full compliance with all the requirements of Section C503.9 is impractical, the applicant is permitted to arrange a pre-application 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.

## SECTION C504
## REPAIRS

**C504.1 General.** Buildings and structures, and parts thereof, shall be repaired in compliance with Section C501.3 and this section. Work on nondamaged components that is necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. Routine maintenance required

by Section C501.3, ordinary repairs exempt from *permit*, and abatement of wear due to normal service conditions shall not be subject to the requirements for *repairs* in this section.

**C504.2 Application.** For the purposes of this code, the following shall be considered repairs.

1. Glass only replacements in an existing sash and frame.
2. *Roof repairs*.
3. Air barriers shall not be required for *roof repair* where the repairs to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.
4. 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.
5. *Repairs* where only the bulb and/or ballast within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power.

## SECTION C505
## CHANGE OF SPACE CONDITIONING, OCCUPANCY OR USE

**C505.1 General.** Buildings or spaces undergoing a change in space conditioning alteration shall comply with Sections C505.1.1, C505.1.2, C505.2 and C505.4. Buildings or spaces undergoing a change in occupancy ((~~alterations~~)) alteration shall comply with Sections C505.1.1, C505.1.2, C505.3 and C505.4. Spaces changing from one use type to another shall also comply with Section C505.5.

Buildings or spaces undergoing a change in space conditioning, change in occupancy or change in use shall conform to the provisions of this code without requiring the unaltered portion of the existing building to comply with this code. Alterations shall be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the alteration.

((~~A change in space conditioning alteration shall be deemed to comply with this code if the alteration area alone complies or if the alteration area is combined with all other spaces within the existing building that are of the same space conditioning category according to Section C505.2 to demonstrate compliance. A change in occupancy alteration shall be deemed to comply with this code if the alteration area alone complies or if the existing building and the alteration area are combined to demonstrate complete for the whole building. This allowance applies to prescriptive compliance in accordance with Section C505.4 or total building performance in accordance with Section C407.~~))

Buildings or spaces ((~~that were permitted prior to the 2009 Washington State energy code, or were originally permitted as unconditioned, may comply with this section as follows~~)) are permitted to utilize one of the following modifications for compliance with this section:

1. Increased envelope UA with prescriptive compliance. Where the component performance alternative in Section C402.1.5 is used to demonstrate compliance with this section, and the project area complies with all other requirements of this code, the Proposed Total UA is allowed to be up to 110 percent of the Allowable Total UA. This exception ((~~may~~)) is permitted to be applied to the project area alone, or to the existing building and project area combined as a whole building.
2. Increased site energy use with total building performance compliance. Where total building performance in accordance with Section C407 is used to demonstrate compliance with this section, the total annual ((~~carbon emissions from~~)) energy consumption of the proposed design is allowed to be up to 110 percent of the annual ((~~carbon emissions from~~)) energy consumption allowed by Section C407.3. This exception ((~~may~~)) is permitted to be applied to the project area alone, or to the existing building and project area combined as a whole building.

**C505.1.1 Additional energy efficiency credits.** Buildings or spaces that are required to comply with Sections C505.2 or C505.3 shall also comply with Section C502.1.1 in the same manner as an addition.

**C505.1.2 Renewable energy.** Buildings or spaces that are required to comply with Section C505.2 or C505.3 shall also comply with Section C502.1.2 in the same manner as an addition.

**C505.2 Change in space conditioning.** For the purposes of this section, space conditioning area categories include: low energy space in accordance with Section C402.1.1.1, *semi-heated space*, and *conditioned space*. Spaces undergoing a change in space conditioning alteration shall be brought up to full compliance with this code, other than Sections C502, C503, and C504, for all disciplines in the following cases:

1. Any low energy space in accordance with Section C402.1.1.1 that is altered to become *conditioned space* or *semi-heated space*. ((~~shall be brought into full compliance with this code.~~))

2. Any semi-heated space in accordance with Section C402.1.1.2 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 brought into full compliance with this code.~~

~~For buildings with more than one space conditioning category, the interior partition walls, ceilings, floors and fenestration that separate space conditioning areas shall comply with the thermal envelope requirements per the area with the highest level of space conditioning.~~

~~A change in space conditioning project shall be deemed to comply with this code if the project area alone complies or if the existing building and the project area combined comply with this code as a whole building.~~))

Interior walls, ceilings, floors and fenestration that separate conditioned spaces from low energy or semi-heated spaces shall comply with the thermal envelope requirements for conditioned space. Interior walls, ceilings, floors and fenestration that separate semi-heated spaces from low energy spaces shall comply with the thermal envelope requirements for semi-heated space.

A change in space conditioning is permitted to demonstrate compliance either if the alteration area alone complies or if the alteration area combined with all existing spaces of the same space conditioning area category complies. This applies to either prescriptive compliance in accordance with Section C505.4 or total building performance in accordance with Section C407.

**EXCEPTIONS:**

1. A change in space conditioning does not require full compliance with this code if the existing heated but not cooled space is altered to become both heated and cooled solely by replacement of the existing heating-only HVAC system with an electric heat pump HVAC system, provided that there is no change in the use or occupancy classification of the area served by the HVAC system that would increase the cooling load, and the new system includes a DOAS with energy recovery in compliance with Section C403.3.5.
2. The addition of cooling equipment to an already-conditioned floor area of less than 2,000 square feet does not trigger the requirement to comply with this Section 505.2.

**C505.3 Change in occupancy.** Spaces undergoing a change in occupancy alteration shall be brought up to full compliance with this code, other than Sections C502, C503, and C504, for all disciplines in the following cases:

1. Any space that is converted from a Group F, S or U occupancy to an occupancy other than Group F, S or U.
2. Any space that is converted to a Group R dwelling unit or portion thereof, from another use or occupancy.
3. Any Group R dwelling unit or portion thereof permitted prior to July 1, 2002, that is converted to a commercial use or occupancy.

A change in occupancy is permitted to demonstrate compliance either if the alteration area alone complies or if the alteration area combined with all existing spaces of the same space conditioning area category complies. This applies to either prescriptive compliance in accordance with Section C505.4 or total building performance in accordance with Section C407.

**C505.4 Prescriptive compliance.** Change in space conditioning and change in occupancy shall comply with Sections C505.4.1 through C505.4.6.

**C505.4.1 Vertical fenestration.** ((~~A~~)) Either a change in space conditioning or change in occupancy ((~~alteration~~)) to a space or building with vertical fenestration shall comply with the following:

1. Where the vertical fenestration area of the alteration combined with the vertical fenestration area of all equivalent space conditioning areas in the existing building results in a total vertical fenestration area that is less than or equal to the maximum allowed by Section C402.4.1, the alteration shall comply with Section C402.4.
2. Where the vertical fenestration area of the alteration combined with the vertical fenestration area of all equivalent space conditioning areas in the existing building results in a total vertical fenestration area that is greater than the maximum allowed by Section C402.4.1, the alteration shall comply with one of the following:
   2.1. Component performance alternative with target area adjustment in accordance with Section C402.1.5 for the alteration area of the building only.
   2.2. Alteration area is combined with all equivalent space conditioning areas to demonstrate compliance with the component performance alternative.
   2.3. Total building performance in accordance with Section C407 for the alteration area of the building only.
   2.4. Alteration area is combined with all equivalent space conditioning areas to demonstrate total building performance compliance.
   2.5. The alteration does not increase the existing fenestration area.

**C505.4.1.2 Skylights.** ((~~A~~)) Either a change in space conditioning ((~~alteration~~)) or change in occupancy to a space or building with skylights shall comply with the following:

1. Where the skylight area of the alteration combined with the skylight area of all equivalent space conditioning areas in the existing building results in a total skylight area that is less than or equal to the maximum allowed by Section C402.4.1, the alteration shall comply with Section C402.4.
2. Where the skylight area of the alteration combined with the skylight area of all equivalent space conditioning areas in the existing building results in a total skylight area that is greater than the maximum allowed by Section C402.4.1, the alteration shall comply with one of the following:
   2.1. Component performance alternative with target area adjustment in accordance with Section C402.1.5 for the alteration area of the building only.
   2.2. Alteration area is combined with all equivalent space conditioning areas to demonstrate compliance with the component performance alternative.
   2.3. Total building performance in accordance with Section C407 for the alteration area of the building only.
   2.4. Alteration area is combined with all equivalent space conditioning areas to demonstrate total building performance compliance.

**C505.4.2 Building mechanical systems.** All new and existing mechanical systems and equipment that serve the new building heating, cooling and ventilation needs of the alteration area shall comply with Sections C403, C408.2, ((~~C409.5~~)) C506.1 and C501.6.

**C505.4.3 Service water-heating systems.** All new and existing service water-heating systems and equipment that serve the new service water-heating needs of the alteration area shall comply with Sections C404, C408.3, ((~~C409.5~~)) C506.1 and C501.6.

**C505.4.4 Pools and permanent spas.** All new and existing systems and equipment serving pools and permanent spas that are included in the alteration shall comply with Sections C404.11, C408.3, ((~~C409.5~~)) C506.1 and C501.6.

**C505.4.5 Electrical power and lighting systems and motors.** All new and existing electrical power and lighting systems and motors that are included in the alteration shall comply with Sections C405, C408.4, ((~~C409.5~~)) C506.1 and C501.6.

**C505.4.6 Refrigeration systems.** All new and existing refrigerated spaces and refrigeration systems and equipment that serve the new refrigeration needs of the alteration area shall comply with Sections C410, C408.7, ((~~C409.5~~)) C506.1 and C501.6.

**C505.5 Change of use.** Where the use in a space changes from one use in Table C405.4.2 (1) or (2) to another use in Table C405.4.2 (1) or (2), the installed lighting wattage in the space shall comply with Section C405.4 and the ventilation air flow provided to the space shall be in accordance with Chapter 4 of the International Mechanical Code.

## SECTION C506
## METERING FOR EXISTING BUILDINGS

**C506.1 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.

**C506.1.1 Small existing buildings.** Metering and data acquisition systems shall be provided for additions over 25,000 square feet to buildings that were constructed subject to the requirements of this section, in accordance with the requirements of Sections C409.2 and C409.3.

**C506.2 Metering for the addition or replacement of HVAC equipment in existing buildings.** Where HVAC equipment is added or replaced, metering shall be provided according to Sections C506.2.1 or C506.2.2, as applicable.

**C506.2.1 Addition or replacement of individual HVAC equipment pieces.** Where HVAC equipment is added or replaced, but compliance with Section C506.2.2 is not required, metering shall be provided as follows, and the data from these meters is permitted to either be stored locally using a manual totalizing meter or other means at the meter or fed into a central data collection system.

1. Electrical metering shall be provided for all of the following:
   a. Each new or existing branch circuit serving a new piece of HVAC equipment with minimum circuit ampacity (MCA) that equates to 50 kVA or more. A single meter is permitted to serve multiple circuits of the same sub-metering category from Section C409.3.
   b. Each new or existing branch circuit supplied by a new electrical panel that is dedicated to serving HVAC equipment. It shall be permitted to meter the circuits individually or in aggregate.

c. Each new HVAC fan or pump on a variable speed drive, where the fan, pump, or variable speed drive are new, unless the variable speed drive is integral to a packaged HVAC unit or the existing variable speed drive does not have the capability to provide electric metering output.

2. Natural gas metering shall be provided for each new natural gas connection that is rated at 1,000 kBTU or higher. A single meter is permitted to serve multiple equipment pieces of the same sub-metering category from Section C409.3; HVAC, water heating or process.

**C506.2.2 Addition or replacement of the majority of HVAC equipment in a building.** 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.

**C506.3 Tenant space electrical sub-metering for existing buildings.** For tenant improvements in which a single tenant will occupy a full floor or multiple floors 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.

**C506.4 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.

# Chapter 6 [CE]

# REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section C106.

## AAMA

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| AAMA/WDMA/CSA 101/I.S.2/A C440—17 | North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights | Table C402.4.1.1.2 |

## AHAM

Association of Home Appliance Manufacturers
1111 19th Street, N.W., Suite 402
Washington, D.C. 20036

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ANSI/AHAM RAC-1—2008 | Room Air Conditioners | C403.3.2(((~~(3)~~))) (4) |
| AHAM HRF-1—2017 | Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers | Table C410.1(1) |

## AHRI

Air Conditioning, Heating, and Refrigeration Institute
4100 North Fairfax Drive, Suite 200
Arlington, VA 22203

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ISO/AHRI/ASHRAE 5801—2017 | Fans—Performance Testing Using Standardized Airways | C403.8.1.1 |
| ISO/AHRI/ASHRAE 13256-1 (2017) | Water-source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps | Table C403.3.2(14) |
| ISO/AHRI/ASHRAE 13256-2 (2017) | Water-source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-water and Brine-to-water Heat Pumps | Table C403.3.2(14) |
| 210/240—(2017 and 2023) | Performance Rating of Unitary Air Conditioning and Air-source Heat Pump Equipment | Table C403.3.2(1), Table C403.3.2(2) |
| 310/380—2017 | Standard for Packaged Terminal Air Conditioners and Heat Pumps | Table C403.3.2(4) |
| 340/360—2018 | Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment | Table C403.3.2(1), Table C403.3.2(2) |

**ANSI—continued**

| | | |
|---|---|---|
| ANSI/ASME A17.1—2010 | Safety code for elevators and escalators | C405.12.1 |
| ANSI/CTA 2045-A—2018 | Modular Communications Interface for Energy Management | C404.14 |
| ANSI/CTA 2045-B—2021 | Modular Communications Interface for Energy Management | C404.14 |
| Z21.10.3/CSA 4.3—((~~11~~)) 17 | Gas Water Heaters, Volume III—Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating Tank and Instantaneous | Table C404.2 |
| Z21.47/CSA 2.3 16 | Gas-fired Central Furnaces | Table C403.3.2(5) |
| Z83.8/CSA 2.6—16 | Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters and Gas-fired Duct Furnaces | Table C403.3.2(5) |

# APSP

The Association of Pool and Spa Professionals
2111 Eisenhower Avenue
Alexandria, VA 22314

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 14— 2019 | American National Standards for Portable Electric Spa Efficiency | C404.12 |

# ASABE

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| S640—2017 | Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms) | C405.3 |

# ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, N.E.
Atlanta, GA 30329-2305

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ANSI/ASHRAE/ACCA Standard 127-2007 | Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners | ((~~Table C403.3.2(9)~~)) C403.5 |
| ANSI/ASHRAE/ACCA Standard 183—((~~2007~~)) RA2017 | Peak Cooling and Heating Load Calculations in Buildings, Except Low-rise Residential Buildings | ((~~Table C403.3.2(9)~~)) C403.5, C403.1.2 |
| ASHRAE—((~~2016~~)) 2020 | ASHRAE HVAC Systems and Equipment Handbook—((~~2016~~)) 2020 | C403.1.2 |
| ISO/AHRI/ASHRAE 13256-1 (((~~2011~~)) 2012) | Water-source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps | Table C403.3.2(((~~2~~))) (14) |
| ISO/AHRI/ASHRAE 13256-2 (((~~2011~~)) 2012) | Water-source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-water and Brine-to-water Heat Pumps | Table C403.3.2(((~~2~~))) (14) |

**ASHRAE—continued**

| | | |
|---|---|---|
| 90.1—((2016)) 2022 | Energy Standard for Buildings Except Low-rise Residential Buildings (ANSI/ASHRAE/IESNA 90.1—((2010)) 2022 | Table C402.1.3, Table C402.1.4, C406.2 |
| 90.4—((2019)) 2022 | Energy Standard for Data Centers (with Addenda a, b, d, e) | C403.1.3 |
| 146—2011 | Testing and Rating Pool Heaters | Table C404.2 |

# ASME

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ASME A17.1/CSA B44—((2016)) 2019 | Safety Code for Elevators and Escalators | C405.9.2 |
| BPVC Section IV-2021 | Boiler and Pressure Vessel Code, Section IV—Rules for Construction of Heating Boilers | C404.14 |
| BPVC Section X-2021 | Boiler and Pressure Vessel Code, Section X—Fiber-Reinforced Plastic Pressure Vessels | C404.14 |

# ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2859

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| C 90—((14)) 206A | Specification for Load-bearing Concrete Masonry Units | Table C402.1.3 |
| C518—17 | Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus | Table C403.10.1.1 |
| C1363—11 | Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus | C303.1.4.1, Table C402.1.4 |
| C1363—11 | Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus | C303.1.4.1, Table C402.1.4, C402.2.7 |
| C 1371—15 | Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers | Table C402.4 |
| C 1549—09 | Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using A Portable Solar Reflectometer | Table C402.4 |
| D 1003—13 | Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics | C402.4.2.2 |
| E 283—04 (2012) | Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen | C402.5.8 |
| E 408—13 | Test Methods for Total Normal Emittance of Surfaces Using Inspection-meter Techniques | Table ((C402.4)) C402.3 |
| E 779—((10)) 2018 | Standard Test Method for Determining Air Leakage Rate by Fan Pressurization | C402.5.1.2.3 |
| E 903—12 | Standard Test Method Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005) | Table C402.4 |
| E 1677—11 | Standard Specification for an Air-retarder (AR) Material or System for Low-rise Framed Building Walls | C402.5.1.2.2 |
| E 1827—2011(2017) | Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door | C402.5.2, C402.5.3 |

**ASTM—continued**

| | | |
|---|---|---|
| E 1918—06 (2015) | Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field | Table C402.4 |
| E 1980—11 | Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-sloped Opaque Surfaces | Table C402.2.1.1 |
| E 2178—13 | Standard Test Method for Air Permanence of Building Materials | C402.4 |
| E 2357—11 | Standard Test Method for Determining Air Leakage of Air Barrier Assemblies | C402.5.1.2.2 |
| F 1281—2017 | Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL_PEX) Pressure Pipe | Table C404.5.2.1 |

# CSA

Canadian Standards Association
5060 Spectrum Way
Mississauga, Ontario, Canada L4W 5N6

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| AAMA/WDMA/CSA 101/I.S.2/A440—11 | North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights | Table C402.4.2 |
| CSA B55.1—2015 | Test Method for Measuring Efficiency and Pressure Loss of DWHR Units | C404.10 |
| CSA B55.2—2015 | Drain Water Heat Recovery Units | C404.10 |

# CSA

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| CAN/CSA-C439-18 | Laboratory methods of test for rating the performance of heat/energy-recovery ventilators | Table C403.8.4 |

# CTA

Consumer Technology Association
1919 S Eads Street
Arlington, VA 22202

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ANSI/CTA 2045-A—2018 | Modular Communications Interface for Energy Management | C404.14 |
| ANSI/CTA 2045-B—2021 | Modular Communications Interface for Energy Management | C404.14 |

# CTI

Cooling Technology Institute
2611 FM 1960 West, Suite A-101
Houston, TX 77068

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ATC 105 (((~~00~~)))—2019 | Acceptance Test Code for Water Cooling Tower | Table C403.3.2(((~~8~~))) (7) |
| ATC 105DS—2018 | Acceptance Test Code for Dry Fluid Coolers | Table C403.3.2(7) |
| ATC 105S—11 | Acceptance Test Code for Closed Circuit Cooling Towers | Table C403.3.2(((~~8~~))) (7) |

**CTI—continued**

| | | |
|---|---|---|
| ATC 106—11 | Acceptance Test Code for Mechanical Draft Evaporative Vapor Condensers | Table C403.3.2(((~~8~~))) (7) |
| STD 201—((~~11~~)) 17 | Standard for Certification of Water Cooling Towers Thermal Performances | Table C403.3.2(((~~8~~))) (7) |

# DASMA

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 105—((~~92 (R2004)—13~~)) 17 | Test Method for Thermal Transmittance and Air Infiltration of Garage Doors | Table C402.4.2 |

# DOE

U.S. Department of Energy
c/o Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402-9325

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 10 C.F.R., Part 430—2015 | Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule | Table C403.3.2(((~~4~~))) (1), Table C403.3.2(((~~5~~))) (2), Table C403.3.2(5), Table C403.3.2(6), Table C403.3.2(14), Table C404.2 |
| ((~~10 C.F.R., Part 430, Subpart B, Appendix N—2015~~ | ~~Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers.~~ | ~~C202~~)) |
| 10 C.F.R., Part 431—2015 | Energy Efficiency Program for Certain Commercial and Industrial Equipment: Test Procedures and Efficiency Standards; Final Rules | Table C403.3.2(((~~5~~))) (6), C403.8.4, C403.11, Table ((~~C406.2(5)~~)) C403.11, C403.11.2, C405.7, Table C405.7, C405.8, Table C405.8(1), Table C405.8(2), Table C405.8(3) |
| ((~~NAECA 87—(88)~~ | ~~National Appliance Energy Conservation Act 1987 [(Public Law 100-12 (with Amendments of 1988 P.L. 100-357)]~~ | ~~Tables C403.3.2(1), (2), (4)~~)) |

# HVI

Home Ventilating Institute
1740 Dell Range Blvd., Ste. H, PMB 450
Cheyenne, WY 82009

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 920—2020 | Product Performance Certification Procedure Including Verification and Challenge | C403.3.5.1, C403.3.6 |

# IAPMO

International Association of Plumbing and Mechanical Officials
4755 E. Philadelphia Street
Ontario, CA 91761

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| UPC—((~~2015~~)) 2021 | Uniform Plumbing Code | C201.3, ((~~C501.4~~)) C501.2 |

# ICC

International Code Council, Inc.
500 New Jersey Avenue, N.W.,
6th Floor
Washington, D.C. 20001

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| IBC—((~~15~~)) 21 | International Building Code | C201.3, C303.2, C402.4.3, C501.2 |
| ICC 500—2020 | Standard for the Design and Construction of Storm Shelters | C402.4.2 |
| IFC—((~~15~~)) 21 | International Fire Code | C201.3, ((~~C501.4~~)) C501.2 |
| IFGC—((~~15~~)) 21 | International Fuel Gas Code | C201.3, ((~~C501.4~~)) C501.2 |
| IMC—((~~15~~)) 21 | International Mechanical Code | C106.3, C201.3, C402.5.3, C403.2.2.1, C403.2.2.2, C403.3.5, C403.3.5.1, C403.6.1, C403.6.5, C403.6.10, C403.7.1, C403.7.2, C403.7.5, C403.7.5.1, C403.7.6, C403.7.7.3, C403.7.8.1, C403.7.8.4, C403.8.4, C403.8.5.1, Table C403.10.1, C403.10.1.2, Table C403.10.1.2, C403.10.2.2, C403.12, C406.6, C408.2.2.1, ((~~C501.4~~)) C501.2 |

# IEEE

The Institute of Electrical and Electronic Engineers, Inc.
3 Park Avenue
New York, NY 10016

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| IEEE 515.1—2012 | IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications | C404.6.2 |

# ((~~IESNA~~)) IES

Illuminating Engineering Society ((~~of North America~~))
120 Wall Street, 17th Floor
New York, NY 10005-4001

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ANSI/ASHRAE/IESNA 90.1—((~~2016~~)) 2019 | Energy Standard for Buildings Except Low-rise Residential Buildings | Table C402.1.3, Table C402.1.4, Table C407.5.1 |

# ISO

International Organization for Standardization
1, rue de Varembe, Case postale 56, CH-1211
Geneva, Switzerland

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ISO/AHRI/ASHRAE 13256-1 (2017) | Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-air and Brine-to-air Heat Pumps | C403.3.2(((~~2~~))) (14) |
| ISO/AHRI/ASHRAE 13256-2 (2017) | Water-Source Heat Pumps—Testing and Rating for Performance—Part 2: Water-to-water and Brine-to-water Heat Pumps | C403.3.2(((~~2~~))) (14) |
| 25745-2:2015 | Energy Performance of Lifts, Escalators and Moving Walks—Part 2: Energy Calculation and Classification for Lifts (Elevators) | C406.2.14 |

# NEEA

Northwest Energy Efficiency Alliance
421 SW 6th Ave.
Suite 600
Portland, OR 97204

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| AWHS Vers. 8.0—2022 | Advanced Water Heating Specification | C404.2.1 |

# NEMA

National Electric Manufacturers Association
1300 North 17th Street
Suite 1752
Rosslyn, VA 22209

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| ((~~TP-1-2002~~ | ~~Guide for Determining Energy Efficiency for Distribution Transformers~~ | ~~C405.9~~)) |
| ANSI/NEMA WD 6-2016 | Wiring Devices—Dimensional Specifications | C405.12 |
| MGI—((~~2014~~)) 2016 | Motors and Generators | C202 |
| TP-1-2002 | Guide for Determining Energy Efficiency for Distribution Transformers | C405.9 |

# NFRC

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

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 100—((~~2017~~)) 2020 | Procedure for Determining Fenestration Product U-factors | C303.1.2, C402.2.2 |
| 200—((~~2017~~)) 2020 | Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence | C303.1.3, C402.4.1.1 |
| 202—2017 | Procedure for Determining Fenestration Product Visible Transmittance at Normal Incidence | C202 |
| NFRC 203—2017 | Procedure for Determining Visible Transmittance of Tubular Daylighting Devices | C202, C402.4.2 |
| 400—2017 | Procedure for Determining Fenestration Product Air Leakage | Table C402.4.2 |

# SMACNA

Sheet Metal and Air Conditioning Contractors National Association, Inc.
4021 Lafayette Center Drive
Chantilly, VA 20151-1209

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| SMACNA—2012 | HVAC Air Duct Leakage Test Manual | C403.10.2.3 |

# UL

Underwriters Laboratories
333 Pfingsten Road
Northbrook, IL 60062-2096

| Standard reference number | Title | Referenced in code section number |
|---|---|---|
| 710—12 | Exhaust Hoods for Commercial Cooking Equipment | C403.7.5 |
| 727—((~~06~~)) 18 | Oil-fired Central Furnaces—with Revisions through April 2010 | Table C403.3.2(4), Table C403.3.2(5) |
| 731—((~~95~~)) 18 | Oil-fired Unit Heaters—with Revisions through April 2010 | Table C403.3.2(((~~4~~))) (5) |

# CHAPTER 1 [RE]
# 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 ((~~*Washington State Energy Code-Residential*~~,)) "Seattle Residential Energy Code," and shall be cited as such. It is referred to herein as "this code."

The 2021 edition of the Washington State Energy Code is hereby adopted. The Washington State Energy Code adopted under chapter 51-11R WAC shall become effective in all counties and cities of this state on March 15, 2024.

**SDCI Informative Note:** The Seattle Residential Energy Code consists of Chapter 1 [RE] through Chapter 6 [RE] and Appendices A through E.

**R101.2 Scope.** This code applies to *residential buildings* and the buildings sites and associated systems and equipment. This code shall be the maximum and minimum energy code for residential construction in each town, city and county. Residential *sleeping units*, Group I-1, Condition 2 assisted living facilities licensed by Washington state under chapter 388-78A WAC and Group I-1, Condition 2 residential treatment facilities licensed by Washington state under chapter 246-337 WAC shall utilize the commercial building sections of the energy code regardless of the number of stories of height above grade plane.

**R101.3 Intent.** This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

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

**R101.5 Compliance.** *Residential buildings* shall meet the provisions of ((~~WSEC~~)) Seattle Energy Code—Residential Provisions. *Commercial buildings* shall meet the provisions of ((~~WSEC~~)) Seattle Energy Code—Commercial Provisions.

**R101.5.1 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.

**R101.6 Landmark buildings.** The building official may modify the specific requirements of this code for *landmarks* and require in lieu thereof alternate requirements 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. A *landmark* is 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.

## SECTION R102
## ALTERNATIVE MATERIALS, DESIGN AND METHODS OF CONSTRUCTION AND EQUIPMENT

**R102.1 General.** The provisions of this code ((~~are not intended to~~)) do not prevent the installation of any material or to prohibit any design or method of construction prohibited by this code or not specifically ((~~prescribed~~)) allowed by this code, provided that any such alternative has been *approved*. The code official shall have the authority to approve an alternate material, design or method of construction upon the written application of the owner or the owner's authorized agent. The code official shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code for strength, effectiveness, fire resistance, durability, energy efficiency and safety. The code official shall respond in writing, stating the reasons why the alternative was *approved* or was not *approved*.

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

**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, technical reports, and other supporting data shall ((~~be submitted in one or more sets, or in a digital format where allowed by the *code official*, with each application for a permit~~)) 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. ((~~The construction documents and technical reports 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, the following as applicable:

1. Energy compliance path per Section R401.2.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and SHGCs.
4. Area-weighted *U*-factor and SHGC calculations.
5. Mechanical system design criteria.
6. Mechanical and service water heating system and equipment types, sizes and efficiencies.
7. Equipment and systems controls
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.

**((~~R103.2.1~~)) R103.2.2 Building thermal envelope depiction.** The building's thermal envelope shall be represented on the construction documents.

((~~**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. The code official is authorized to utilize a registered design professional or other approved entity not affiliated with the building design or construction in conducting the review of the plans and specifications for compliance with the code.~~

**~~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.** Work shall be installed in accordance with the *approved* construction documents, and any 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
## FEES

**R104.1 Fees.** ((~~A permit shall not be issued until the fees prescribed in Section R104.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.~~)) 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.

~~((**R104.2 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.~~

~~**R104.3 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.~~

~~**R104.4 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.~~

~~**R104.5 Refunds.** The *code official* is authorized to establish a refund policy.~~))

## SECTION R105
## INSPECTIONS

**R105.1 General.** Construction or work for which a permit is required shall be subject to inspection by the *code official* ((~~or his or her designated agent, and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*~~)) in accordance with this section, the International Residential Code or International Building Code, and the Seattle Electrical Code. ((~~It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Neither the code official nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material, product, system or building component required to allow inspection to validate compliance with this code.~~))

**R105.2 Required inspections.** The *code official* or his or her designated agent, upon notification, shall make the inspections set forth in Sections R105.2.1 through R105.2.5.

**R105.2.1 Footing and foundation inspection.** Inspections associated with footings and foundations shall verify compliance with the code as to R-value, location, thickness, depth of burial and protection of insulation as required by the code and approved plans and specifications.

**R105.2.2 Framing and rough-in inspection.** Inspections at framing and rough-in shall be made before application of interior finish and shall verify compliance with the code as to types of insulation and corresponding R-values and their correct location and proper installation; fenestration properties (U-factor and SHCG) and proper installation; and air leakage controls as required by the code and approved plans and specifications.

**R105.2.2.1 Wall insulation inspection.** The *code official*, upon notification, shall make a wall insulation inspection in addition to those inspections required in Section R109 of the *International Residential Code*. This inspection shall be made after all wall and cavity insulation is in place and prior to cover.

**R105.2.3 Plumbing rough-in inspection.** Inspections at plumbing rough-in shall verify compliance as required by the code and approved plans and specifications as to types of insulation and corresponding R-values and protection, and required controls.

**R105.2.4 Mechanical rough-in inspection.** Inspections at mechanical rough-in shall verity compliance as required by the code and approved plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding R-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation and minimum fan efficiency.

**Exception:** Systems serving multiple dwelling units shall be inspected in accordance with Section R105.2.4.

**R105.2.5 Final inspection.** The building shall have a final inspection and not be occupied until *approved*.

**R105.3 Reinspection.** A building shall be reinspected when determined necessary by the *code official*.

~~((**R105.4 Approved inspection agencies.** The *code official* is authorized to accept reports of third-party inspection agencies not affiliated with the building design or construction, provided such agencies are *approved* as to qualifications and reliability relevant to the building components and systems they are inspecting.))~~

**R105.5 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *code official* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

**R105.6 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the *code official* for inspection and testing.

## SECTION R106
## NOTICE OF APPROVAL

~~((**R106.1 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*.~~

~~**R106.2 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 R107
## VALIDITY

**R107.1 General.** If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder of this code.

## SECTION R108
## REFERENCED STANDARDS

**R108.1 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 R108.1.1 and R108.1.2.

**R108.1.1 ((~~Conflicts~~)) <u>References to other codes</u>.** ((~~Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.~~)) <u>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.</u>

**R108.1.2 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.

**R108.2 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

**R108.3 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 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 shall govern.

## SECTION R109
## ((~~STOP WORK ORDER~~)) ENFORCEMENT

**R109.1 Authority.** ((~~Whenever the *code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a dangerous or unsafe manner, the *code official* is authorized to issue a stop work order.~~)) 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.

((~~**R109.2 Issuance.** The stop work order shall be in writing and shall be given to the owner of the property involved, the owner's authorized agent, or the person performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work is authorized to resume.~~

~~**R109.3 Emergencies.** Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.~~

~~**R109.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject fines established by the authority having jurisdiction.~~))

## SECTION R110
## ((~~MEANS OF APPEALS~~)) ADMINISTRATIVE REVIEW

((~~**R110.1 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 board of appeals shall be appointed by the applicable governing authority 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*.~~

~~**R110.2 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 equivalent or better form of construction is proposed. The board shall have no authority to waive requirements of this code or interpret the administration of this code.~~

~~**R110.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training and are not employees of the jurisdiction.~~))

**R110.1 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*.

**R110.2 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*.

**R110.3 Reserved.**

**R110.4 Administration.** The code official shall take immediate action in accordance with the decision of the board.

## SECTION R111
## 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 of the International Residential Code, as applicable.

## SECTION R112
## 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 Construction and Inspections 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.

# CHAPTER 3 [RE]
# GENERAL REQUIREMENTS

## SECTION R301
## CLIMATE ZONES

**R301.1 General.** Climate zones from Table R301.1 shall be used in determining the applicable requirements from Chapter 4.

**TABLE R301.1**
**CLIMATE ZONES, MOISTURE REGIMES, AND WARM-HUMID DESIGNATIONS BY STATE AND COUNTY**

| Key: A – Moist, B – Dry, C – Marine. Absence of moisture designation indicates moisture regime is irrelevant. | |
|---|---|
| **WASHINGTON** | |
| 5B Adams | 4C Lewis |
| 5B Asotin | 5B Lincoln |
| 5B Benton | 4C Mason |
| 5B Chelan | 5B Okanogan |
| 4C Clallam | 4C Pacific |
| 4C Clark | 5B Pend Oreille |
| 5B Columbia | 4C Pierce |
| 4C Cowlitz | 4C San Juan |
| 5B Douglas | 4C Skagit |
| 5B Ferry | 5B Skamania |
| 5B Franklin | 4C Snohomish |
| 5B Garfield | 5B Spokane |
| 5B Grant | 5B Stevens |
| 4C Grays Harbor | 4C Thurston |
| 4C Island | 4C Wahkiakum |
| 4C Jefferson | 5B Walla Walla |
| 4C King | 4C Whatcom |
| 4C Kitsap | 5B Whitman |
| 5B Kittitas | 5B Yakima |
| 5B Klickitat | |

## SECTION R302
## DESIGN CONDITIONS

**R302.1 Interior design conditions.** The interior design temperatures used for heating and cooling load calculations shall be a maximum of 72°F (22°C) for heating and minimum of 75°F (24°C) for cooling.

**R302.2 Exterior design conditions.** The heating or cooling outdoor design temperatures shall be selected from Appendix ((~~RC~~)) C.

## SECTION R303
## MATERIALS, SYSTEMS AND EQUIPMENT

**R303.1 Identification.** Materials, systems and equipment shall be identified in a manner that will allow a determination of compliance with the applicable provisions of this code.

**R303.1.1 Building thermal envelope insulation.** An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternately, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown or sprayed insulation (fiberglass and cellulose), the initial installed thickness,

The drawings included with the building permit application shall identify which options have been selected and the point value of each option, regardless of whether separate mechanical, plumbing, electrical, or other permits are utilized for the project.

**TABLE R406.3**
**ENERGY CREDITS**

| OPTION | DESCRIPTION | CREDIT(S) | |
|---|---|---|---|
| | | All Other | Group R-2[b] |
| **1. EFFICIENT BUILDING ENVELOPE OPTIONS** | Only one option from Items 1.1 through 1.4 may be selected in this category.<br>Compliance with the conductive UA targets is demonstrated using Section R402.1.5, Total UA alternative, where [1-(Proposed UA/Target UA)] > the required %UA reduction | | |
| 1.1 | Prescriptive compliance is based on Table R402.1.3 with the following modifications:<br>Vertical fenestration U = 0.22. | 0.5 | 0.5 |
| 1.2 | Prescriptive compliance is based on Table R402.1.3 with the following modifications:<br>Vertical fenestration U = 0.25<br>Floor R-38<br>Basement wall R-21 int plus R-5 ci<br>Ceiling and single-rafter or joist-vaulted R-60 advanced<br>Slab on grade R-10 perimeter and under entire slab<br>Below grade slab R-10 perimeter and under entire slab<br>or<br>Compliance based on Section R402.1.5: Reduce the Total conductive UA by 15%. | 1.0 | 1.0 |
| 1.3 | Prescriptive compliance is based on Table R402.1.3 with the following modifications:<br>Vertical fenestration U = 0.18<br>Ceiling and single-rafter or joist-vaulted R-60 advanced<br>Floor R-38<br>Basement wall R-21 int plus R-12 ci<br>Slab on grade R-10 perimeter and under entire slab<br>Below grade slab R-10 perimeter and under entire slab<br>or<br>Compliance based on Section R402.1.5: Reduce the Total conductive UA by 22.5%. | 1.5 | 1.5 |
| 1.4 | Prescriptive compliance is based on Table R402.1.3 with the following modifications:<br>Vertical fenestration U = 0.18<br>Ceiling and single-rafter or joist-vaulted R-60 advanced<br>Wood frame wall R-21 int plus R-16 ci<br>Floor R-48<br>Basement wall R-21 int plus R-16 ci<br>Slab on grade R-20 perimeter and under entire slab<br>Below grade slab R-20 perimeter and under entire slab<br>or<br>Compliance based on Section R402.1.5: Reduce the Total conductive UA by 30%. | 2.5 | 2.0 |
| **2. AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION OPTIONS** | Only one option from Items 2.1 through 2.3 may be selected in this category. | | |
| 2.1 | Compliance based on Section R402.4.1.2:<br>Reduce the tested air leakage to 2.0 air changes per hour maximum at 50 Pascals<br>or<br>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.25 cfm/ft$^2$ maximum at 50 Pascals<br>and<br>All whole house ventilation requirements as determined by Section ((~~M1505.3~~)) M1505.4 of the *International Residential Code* or Section ((~~403.8~~)) 403.4.4 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.65.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system. | 1.0 | 1.0 |

**TABLE R406.3—continued**
**ENERGY CREDITS**

| OPTION | DESCRIPTION | CREDIT(S) | |
|---|---|---|---|
| | | All Other | Group R-2[b] |
| 2.2 | Compliance based on Section R402.4.1.2:<br>Reduce the tested air leakage to 1.5 air changes per hour maximum at 50 Pascals<br>or<br>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.20 cfm/ft$^2$ maximum at 50 Pascals<br>and<br>All whole house ventilation requirements as determined by Section ((~~M1505.3~~)) M1505.4 of the *International Residential Code* or Section ((~~403.8~~)) 403.4.4 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.75.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system. | 1.5 | 1.5 |
| 2.3 | Compliance based on Section R402.4.1.2:<br>Reduce the tested air leakage to 0.6 air changes per hour maximum at 50 Pascals<br>or<br>For R-2 Occupancies, optional compliance based on Section R402.4.1.2: Reduce the tested air leakage to 0.15 cfm/ft$^2$ maximum at 50 Pascals<br>and<br>All whole house ventilation requirements as determined by Section ((~~M1505.3~~)) M1505.4 of the *International Residential Code* or Section ((~~403.8~~)) 403.4.4 of the *International Mechanical Code* shall be met with a heat recovery ventilation system with minimum sensible heat recovery efficiency of 0.80. Duct installation shall comply with Section R403.3.2.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the maximum tested building air leakage and shall show the heat recovery ventilation system. | 2.0 | 2.0 |
| **3. HIGH EFFICIENCY HVAC EQUIPMENT OPTIONS** | | | |
| Only one option from Items 3.1 through 3.10 may be selected in this category. Item 3.11 may be taken with Items 3.1 or 3.3[c] only. | | | |
| 3.1[a] | For a System Type 1 in Table R406.2:<br>Energy Star rated (U.S. North) gas or propane furnace with minimum AFUE of 95%.<br>or<br>Energy Star rated (U.S. North) gas or propane boiler with minimum AFUE of 90%<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 1.0 | 1.0 |
| 3.2[a] | For secondary heating system serving System Type 2 in Table R406.2:<br>Energy Star rated (U.S. North) Gas or propane furnace with minimum AFUE of 95%<br>or<br>Energy Star rated (U.S. North) Gas or propane boiler with minimum AFUE of 90%.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 0.5 | 0.5 |
| 3.3[a,c,d] | Air-source centrally ducted heat pump with minimum HSPF2 of 8.1 (HSPF of 9.5).<br>In areas where the winter design temperature as specified in Appendix RC is 23°F or below, a cold climate heat pump found on the NEEP cc ASHP qualified product list shall be used.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 0.5 | N/A |
| 3.4[a,d] | Closed-loop ground source heat pump; with a minimum COP of 3.3<br>or<br>Open loop water source heat pump with a maximum pumping hydraulic head of 150 feet and minimum COP of 3.6.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 1.5 | 1.0 |
| 3.5[d] | Ductless mini-split heat pump system, zonal control: In homes where the primary space heating system is zonal electric heating, a ductless mini-split heat pump system with a minimum HSPF2 of 9 (HSPF of 10.0) shall be installed and provide heating to the largest zone of the housing unit.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 1.5 | 2.0 |

**TABLE R406.3—continued**
**ENERGY CREDITS**

| OPTION | DESCRIPTION | CREDIT(S) | |
|---|---|---|---|
| | | All Other | Group R-2[b] |
| 3.6[a,d] | Air-source, centrally ducted heat pump with minimum HSPF2 of 9.4 (HSPF of 11.0).<br>A centrally ducted air source cold climate variable capacity heat pump (cc VCHP) found on the NEEP cc VCHP qualified product list with a minimum of 9 HSPF2 (10 HSPF) may be used to satisfy this requirement.<br>In areas where the winter design temperature as specified in Appendix RC is 23°F or below, an air source centrally ducted heat pump shall be a cold climate variable capacity heat pump as listed on the NEEP qualified product list.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and the minimum equipment efficiency. | 1.0 | N/A |
| 3.7[a,d,e] | Ductless split system heat pumps with no electric resistance heating in the primary living areas. A ductless heat pump system with a minimum HSPF2 of 9 (HSPF of 10) shall be sized and installed to provide heat to entire dwelling unit at the design outdoor air temperature.<br>**Exception:** In homes with total heating loads of 24,000 or less using multi-zone mini-split systems with nominal ratings of 24,000 or less, the minimum HSPF2 to claim this credit shall be 8.1 (9 HSPF).<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type). | 2.0 | 3.0 |
| 3.8[a,d] | Air-to-water heat pump with minimum COP of 3.2 at 47°F, rated in accordance with AHRI 550/590 by an accredited or certified testing lab.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected, the heated floor area calculation, the heating equipment type(s), the minimum equipment efficiency, and total installed heat capacity (by equipment type). | 1.0 | N/A |
| 3.9 | Gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15.<br>For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units. | 1.5 | 1.5 |
| 3.10[f] | Combination water heating and space heating system shall include one of the following:<br>Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0.<br>or<br>For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0., shall serve all units.<br>or<br>For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall serve all units.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings. | 2.5 | 2.5 |
| 3.11[c] | Connected thermostat meeting ENERGY STAR Certified Smart Thermostats/EPA ENERGY STAR specifications.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the thermostat model. | 0.5 | 0.5 |
| **4. HIGH EFFICIENCY HVAC DISTRIBUTION SYSTEM OPTIONS** | | | |
| 4.1 | HVAC equipment and associated duct system(s) installation shall comply with the requirements of Section R403.3.2.<br>Electric resistance heat, hydronic heating and ductless heat pumps are not permitted under this option.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the heating equipment type and shall show the location of the heating and cooling equipment and all the ductwork. | 0.5 | N/A |

**TABLE R406.3—continued**
**ENERGY CREDITS**

| OPTION | DESCRIPTION | CREDIT(S) | |
|---|---|---|---|
| | | All Other | Group R-2[b] |
| **5. EFFICIENT WATER HEATING OPTIONS** Only one option from Items 5.3 through 5.8 may be selected in this category. Items 5.1 and 5.2 may be combined with any option. | | | |
| 5.1 | A drain water heat recovery unit(s) shall be installed, which captures wastewater heat from at least two showers, including tub/shower combinations. It is acceptable, but not required, for sink water to be connected. Unit shall have a minimum efficiency of 40% if installed for equal flow or a minimum efficiency of 54% if installed for unequal flow. Such units shall be rated in accordance with CSA B55.1 or IAPMO IGC 346-2017 and be so labeled.<br>To qualify to claim this credit, the building permit drawings shall include a plumbing diagram that specifies the drain water heat recovery units and the plumbing layout needed to install it. Labels or other documentation shall be provided that demonstrates that the unit complies with the standard. | 0.5 | 0.5 |
| 5.2 | For Compact Hot Water Distribution system credit, the volume shall store not more than 16 ounces of water between the nearest source of heated water and the termination of the fixture supply pipe where calculated using Section R403.5.2. *Construction documents* shall indicate the ounces of water in piping between the hot water source and the termination of the fixture supply. When the hot water source is the nearest primed plumbing loop or trunk, this must be primed with an On Demand recirculation pump and must run a dedicated ambient return line from the furthest fixture or end of loop to the water heater.<br>To qualify for this credit, the dwelling must have a minimum of 1.5 bathrooms. | 0.5 | 0.5 |
| 5.3 | Water heating system shall include the following:<br>Energy Star rated gas or propane water heater with a minimum UEF of 0.80.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency. | 0.5 | 0.5 |
| 5.4 | Water heating system shall include one of the following:<br>Energy Star rated gas or propane water heater with a minimum UEF of 0.91.<br>or<br>Solar water heating supplementing a minimum standard water heater. Solar water heating will provide a rated minimum savings of 85 therms or 2000 kWh based on the Solar Rating and Certification Corporation (SRCC) Annual Performance of OG-300 Certified Solar Water Heating Systems<br>or<br>Water heater heated by ground source heat pump meeting the requirements of Option 3.4.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings. | 1.0 | 1.0 |
| 5.5 | Water heating system shall include one of the following:<br>Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0.<br>or<br>For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0. shall supply domestic hot water to all units.<br>or<br>For R-2 Occupancy, gas-fired heat pump water heater(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall supply domestic hot water to all units.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings. | 1.5 | 1.5 |
| 5.6 | Water heating system shall include one of the following:<br>Electric heat pump water heater meeting the standards for Tier III of NEEA's advanced water heating specification.<br>or<br>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA's advanced water heating specification, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency. | 2.0 | 2.5 |

**TABLE R406.3—continued**
**ENERGY CREDITS**

| OPTION | DESCRIPTION | CREDIT(S) | |
|---|---|---|---|
| | | All Other | Group R-2[b] |
| 5.7 | Water heating system shall include one of the following:<br>Electric heat pump water heater with a minimum UEF of 2.9 and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors. Equipment shall meet Section 4, requirements for all units, of the NEEA standard *Advanced Water Heating Specification* with the UEF noted above.<br>or<br>For R-2 Occupancy, electric heat pump water heater(s), meeting the standards for Tier III of NEEA's advanced water heating specification and utilizing a split system configuration with the air-to-refrigerant heat exchanger located outdoors, shall supply domestic hot water to all units. If one water heater is serving more than one dwelling unit, all hot water supply and recirculation piping shall be insulated with R-8 minimum pipe insulation.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency. | 2.5 | 3.0 |
| 5.8 | Combination water heating and space heating system shall include one of the following:<br>Gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0.<br>or<br>For R-2 Occupancy, gas-fired heat pump water heater(s) meeting Tier 2 of the NEEA Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0., shall supply all units.<br>or<br>For R-2 Occupancy, gas-fired heat pump(s) meeting ANSI Z21.40.2 and Z21.40.4 or CSA, with a minimum UEF of 1.15, shall supply all units.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall specify the water heater equipment type and the minimum equipment efficiency and, for solar water heating systems, the calculation of the minimum energy savings. | 2.5 | 2.5 |
| **6. RENEWABLE ELECTRIC ENERGY OPTION** | | | |
| 6.1 | For each 600 kWh of electrical generation per housing unit provided annually by on-site wind or solar equipment a 0.5 credit shall be allowed, up to 4.5 credits. Generation shall be calculated as follows:<br>For solar electric systems, the design shall be demonstrated to meet this requirement using the National Renewable Energy Laboratory calculator PVWATTs or approved alternative by the code official.<br>Documentation noting solar access shall be included on the plans.<br>For wind generation projects designs shall document annual power generation based on the following factors:<br>The wind turbine power curve; average annual wind speed at the site; frequency distribution of the wind speed at the site and height of the tower.<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the photovoltaic or wind turbine equipment type, provide documentation of solar and wind access, and include a calculation of the minimum annual energy power production. | 0.5 – 4.5 | 0.5 – 4.5 |
| **7. APPLIANCE PACKAGE OPTION** | | | |
| 7.1 | All of the following appliances shall be new and installed in the dwelling unit and shall meet the following standards:<br>1. Dishwasher, standard – Energy Star rated, Most Efficient 2021 or Dishwasher, compact – Energy Star rated (Version 6.0)<br>2. Refrigerator (if provided) – Energy Star rated (Version 5.1)<br>3. Washing machine (Residential) – Energy Star rated (Version 8.1)<br>4. Dryer – Energy Star rated, Most Efficient 2022<br>To qualify to claim this credit, the building permit drawings shall specify the option being selected and shall show the appliance type and provide documentation of Energy Star compliance. At the time of inspection, all appliances shall be installed and connected to utilities. Dryer ducts and exterior dryer vent caps are not permitted to be installed in the *dwelling unit*. | 0.5 | 1.5 |

a. An alternative heating source sized at a maximum of 0.5 Watts/ft$^2$ (equivalent) of heated floor area or 500 Watts, whichever is bigger, may be installed in the dwelling unit.

b. See Section R401.1 and *residential building* in Section R202 for Group R-2 scope.

c. Option 3.11 can only be taken with Options 3.1 and 3.3. To qualify to claim Option 3.11 with 3.3, the system shall be a 1-2 speed heat pump system. Variable capacity heat pumps are ineligible from claiming this option.

d. This option may only be claimed if serving System Type 4 or 5 from Table R406.2.

e. Primary living areas include living, dining, kitchen, family rooms, and similar areas.

f. Option 3.10 may only be taken with Efficient Water Heating Options 5.1 or 5.2. Equipment sizing for space heating shall be calculated as provided in Section R403.7 with increased capacity to provide a minimum of 75 percent of peak hot water demand or shall be sized in accordance with *approved* manufacturer's specifications or guidance. Supplementary heat for water heating system shall be in accordance with Section R403.5.7.

## SECTION R407
## CERTIFIED PASSIVE HOUSE

**R407.1 General.** Projects shall comply with Section R407.2 or R407.3.

**R407.2 Passive House Institute U.S. (PHIUS).** Projects shall comply with PHIUS+ 2018 Passive Building Standard, including its USDOE Energy Star and Zero Energy Ready Home co-requisites, and performance calculations by PHIUS-approved software. Projects shall also comply with the provisions of Table R405.2.

**R407.2.1 PHIUS documentation.** Prior to the issuance of a building permit, the following items must be provided to the *code official*:

1. A list of compliance features.
2. A PHIUS precertification letter.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHIUS+ 2018 (or later) project certificate.

**R407.3 Passive House Institute (PHI).** Projects shall comply with Low Energy Building Standard, version 9f or later, including performance calculations by PHI-approved software. Projects shall also comply with the provisions of Section R401 through R404.

**R407.3.1 PHI documentation.** Prior to the issuance of a building permit, the following items must be provided to the *code official*:

1. A list of compliance features.
2. A statement from a passive house certifier that the modeled energy performance is congruent with the plans and specifications, and that the modeled performance meets said standard.

Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:

1. A PHI Low Energy Building project certificate.

# CHAPTER 5
# EXISTING BUILDINGS

## SECTION R501
## GENERAL

**R501.1 Scope.** The provisions of this chapter shall control the *alteration*, *repair*, *addition* and change of occupancy of existing buildings and structures.

**R501.1.1 General.** 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. Unaltered portions of the existing building or building supply system shall not be required to comply with this code.

**R501.1.2 Thermostats for accessory dwelling units.** Where a separate dwelling unit, that provides independent facilities for living, sleeping, cooking, bathing and sanitation, is established within or attached to an existing dwelling unit, the heating and cooling for the newly-created dwelling unit shall be controllable with a separate programmable thermostat in accordance with Section R403.1.1.

**R501.2 Compliance.** Additions, alterations, repairs or changes of occupancy to, or relocation of, an existing building, building system or portion thereof shall comply with Sections R502, R503, R504 or R505, respectively, in this code. Changes where unconditioned space is changed to conditioned space shall comply with Section R502.

**R501.3 Maintenance.** Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.

**R501.4 Compliance.** *Alterations*, *repairs*, *additions* and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for *alterations*, *repairs*, *additions* and changes of occupancy or relocation, respectively, in this code and the *International Residential Code*, *International Building Code*, *International Existing Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *Uniform Plumbing Code*, *International Property Maintenance Code*, and ((~~NFPA 70~~)) Seattle Electrical Code.

**R501.5 New and replacement materials.** Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided hazards to life, health or property are not created. Hazardous materials shall not be used where the code for new construction would not permit their use in buildings of similar occupancy, purpose and location.

**R501.6 Historic buildings.** The *code official* may modify the specific requirements of this code for historic buildings and require alternative provisions which will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings or structures that are listed in the state or national register of historic places; designated as a historic property under local or state designation law or survey; certified as a contributing resource with a national register listed or locally designated historic district; or with an opinion or certification that the property is eligible to be listed on the national or state registers of historic places either individually or as a contributing building to a historic district by the state historic preservation officer or the keeper of the national register of historic places.

## SECTION R502
## ADDITIONS

**R502.1 General.** Additions to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code, except as specified in this chapter. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code where the addition alone complies, where the existing building and addition comply with this code as a single building, or where the building with the addition uses no more energy than the existing building. Additions shall be in accordance with Section R502.3 or R502.4.

**R502.1.1 Small additions.** *Additions* not greater than 150 square feet (13.9 $m^2$) shall not be required to comply with Section R406.

**R502.2 Change in space conditioning.** Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

**Exception:** Where the total building performance option in Section R405 is used to comply with this section, the annual energy use of the proposed design is permitted to be 110 percent of the annual energy use otherwise allowed by Section R405.3.

**R502.3 Prescriptive compliance.** Additions shall comply with Sections R502.3.1 through R502.3.4.

**R502.3.1 Building envelope.** New building envelope assemblies that are part of the addition shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.4.

**Exception:** Where nonconditioned space is changed to conditioned space, the building envelope of the addition shall comply where the UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the UA generated for the existing building.

**R502.3.1.1 Existing ceilings with attic spaces.** Where an *addition* greater than 150 square feet (13.9 $m^2$) adjoins existing ceilings with attic spaces, the existing attic spaces shall comply with Section R402.

**R502.3.2 Heating and cooling systems.** HVAC ducts newly installed as part of an *addition* shall comply with Section R403.

**Exception:** The following need not comply with the testing requirements of Section R403.3.3:

1. *Additions* of less than 150 square feet.
2. 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.
3. Existing duct systems constructed, insulated or sealed with asbestos.

**R502.3.3 Service hot water systems.** New service hot water systems that are part of the *addition* shall comply with Section R403.5.

**R502.3.4 Lighting.** New lighting systems that are part of the *addition* shall comply with Section 404.1.

**R502.4 Existing plus addition compliance (Total Building Performance).** Where nonconditioned space is changed to conditioned space the addition shall comply where the annual energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy use of the existing building when modeled in accordance with Section R405. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.

**SDCI Informative Note:** *Alterations* to existing buildings typically do not require R406 Energy Credits. However, Section R406.3 does require energy credits for *additions* larger than 500 square feet, and the Chapter 2 definition of "addition" includes any space, such as a garage or unheated basement, that is converted from unheated to heated space. Therefore, if an ADU (accessory dwelling unit) is created within existing heated space in a dwelling unit, it does not require energy credits. However, if creation of the ADU converts any unheated space to heated space, then all code requirements for additions apply, and if the space converted from unheated to heated is larger than 500 square feet, the R406.3 requirements for energy credits must also be met.

## SECTION R503
## ALTERATIONS

**SDCI Informative Note:** For landmark buildings, see Section R101.6.

**R503.1 General.** *Alterations* to any building or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the existing building or building system to comply with this code. *Alterations* shall be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.

Alterations shall not create an unsafe or hazardous condition or overload existing building systems. *Alterations* shall be such that the existing building or structure uses no more energy than the existing building or structure prior to the *alteration*. Alterations to existing buildings shall comply with Section R503.1.1 through R503.1.4.

The *code official* may approve designs of alterations which do not fully conform to all of the requirements of this code where in the opinion of the *code official* full compliance is physically impossible and/or economically impractical and:

1. The alteration improves the energy efficiency of the building; or
2. The alteration is energy efficient and is necessary for the health, safety, and welfare of the general public.

**R503.1.1 Building envelope.** Building envelope assemblies that are part of the alteration shall comply with Section R402.1.3 or R402.1.5, Sections R402.2.1 through R402.2.10, R402.3.1, R402.3.2, R402.3.5, and R402.4.2.