((~~[1] Interior partitions include any wall, floor, or ceiling that divides frozen storage spaces or cold storage spaces from each other, conditioned spaces, unconditioned spaces, or semi-conditioned spaces.~~))

***

1311.5 Slab-On-Grade Floor: Slab-on-grade insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance of 24 inches or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance of 24 inches. Above grade insulation shall be protected. A 2-inch by 2-inch (maximum) nailer may be placed at the finished floor elevation for attachment of interior finish materials. ((~~Slab-on-grade insulation installed inside the foundation wall shall extend downward from the top of the slab a minimum distance of 24 inches or to the top of the footing, whichever is less. Insulation installed outside the foundation shall extend downward a minimum of 24 inches or to the frost line, whichever is greater. Above grade insulation shall be protected.~~

~~**EXCEPTION:** For monolithic slabs, the insulation shall extend downward from the top of the slab to the bottom of the footing.~~))

1311.6 Radiant Floors (on or below grade): Slab-on-grade insulation shall extend downward from the top of the slab a minimum distance of 36 inches or downward to the top of the footing and horizontal for an aggregate of not less than 36 inches.

((~~If required by the building official where soil conditions warrant such insulation, t~~)) The entire area of a radiant floor shall be thermally isolated from the soil. Where a soil gas control

system is provided below the radiant floor, which results in increased convective flow below the radiant floor, the radiant floor shall be thermally isolated from the sub-floor gravel layer.

1312 ((~~Glazing~~))Fenestration and Doors

1312.1 Standard Procedure for Determination of ((~~Glazing~~))Fenestration and Door U-Factors: U-factors for ((~~glazing~~))fenestration and doors shall be determined, certified and labeled in accordance with Standard RS-31 by a certified independent agency licensed by the National Fenestration Rating Council (NFRC). Compliance shall be based on the ((~~Residential or the Nonresidential~~)) Model Size in Table 4-3 of RS-31. Product samples used for U-factor determinations shall be production line units or representative of units as purchased by the consumer or contractor. Unlabeled ((~~glazing~~))fenestration and doors shall be assigned the default U-factor in Table 10-6.

1312.2 Solar Heat Gain Coefficient and ((~~Shading Coefficient~~))Visible Transmittance: Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT), shall be determined, certified and labeled in accordance with the National Fenestration Rating Council (NFRC) Standard by a certified, independent agency, licensed by the NFRC.

EXCEPTIONS:

1. Shading coefficients (SC) or solar heat gain coefficient for the center of glass shall be an acceptable alternate for compliance with solar heat gain coefficient requirements. Shading coefficients or solar heat gain coefficient for the center of glass for glazing shall be taken from Chapter 15 of Standard RS-1 or from the manufacturer's ((~~test~~)) data using a spectral data file determined in accordance with NFRC 300.

2. For the purposes of 1323, Exception 1, visible transmittance for the center of the glazing assembly shall be taken from Chapter 15 of Standard RS-1 or from the manufacturer's data using a spectral data file determined in accordance with NFRC 300.

3. For dynamic glazing, the minimum SHGC shall be used to demonstrate compliance with this section. Dynamic glazing shall be considered separately from other vertical fenestration, and area-weighted averaging with other vertical fenestration that is not dynamic glazing shall not be permitted.

Informative Note: Using the exception for the SHGC for the center-of-glass does not give the full credit for the overall product (including the frame) that the NFRC-certified SHGC does. Though the SHGC for the frame is not zero (the ASHRAE Handbook of Fundamentals indicates that the SHGC can range from 0.11-0.14 for metal frames and from 0.02 to 0.07 for wood/vinyl/ fiberglass frames), the SHGC for the frame is invariably lower than that for the glass. Consequently, an NFRC-certified SHGC will generally be lower.

Conversely, the VT for the center-of-glass overstates the VT for the overall product (including the frame). The VT for the frame is zero. Consequently, an NFRC-certified VT will always be lower. For this reason, Exception 2 to Section 1312.2 is only applicable to Exception 1 in Section 1323. It is not applicable to other sections.

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1313.2 Roof/Ceiling Assemblies: Roof/ceiling assemblies where the ventilation space above the insulation is less than an average of 12 inches shall be provided with a vapor retarder. (For enclosed attics and enclosed rafter spaces, see Section 1203.2 of the ((~~International~~))Seattle Building Code.) Roof/ceiling assemblies without a vented airspace, allowed only where neither

the roof deck nor the roof structure are made of wood, shall provide a continuous vapor retarder with taped seams.

EXCEPTIONS:

1. Vapor retarders need not be provided where all of the insulation is installed between the roof membrane and the structural roof deck.

2. Unvented attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) shall be permitted if all of the following conditions are met:

    1. The unvented attic space is completely contained within the building thermal envelope.

    2. No interior vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly.

    3. Where wood shingles or shakes are used, a minimum ¼ inch (6 mm) vented air space separates the shingles or shakes and the roofing underlayment above the structural sheathing.

    4. Any air-impermeable insulation shall be a vapor retarder, or shall have a vapor retarder coating or covering in direct contact with the underside of the insulation.

    5. Either items a, b or c shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.

        a. Air-impermeable insulation only. Insulation shall be applied in direct contact to the underside of the structural roof sheathing.

        b. Air-permeable insulation only. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing as specified per WA Climate Zone for condensation control:

            i. Climate Zone 1: R-10 minimum rigid board or air-impermeable insulation R-value.

            ii. Climate Zone 2: R-25 minimum rigid board or air-impermeable insulation R-value.

        c. Air-impermeable and air-permeable insulation. The air-impermeable insulation shall be applied in direct contact to the underside of the structural roof sheathing as specified per WA Climate Zone for

condensation control. The air-permeable insulation shall be installed directly under the air impermeable insulation.

i. Climate Zone 1: R-10 minimum rigid board or air-impermeable insulation R-value.

ii. Climate Zone 2: R-25 minimum rigid board or air-impermeable insulation R-value.

***

1314.2 ((~~Glazing~~))Fenestration and Doors: Air leakage for fenestration and doors shall be determined in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 or ASTM E283 as specified below. Air leakage shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council, and shall be labeled and certified by the manufacturer. Air leakage shall not exceed:

a. 1.0 cfm/ft^2 for glazed swinging entrance doors and revolving doors, tested at a pressure of at least 1.57 pounds per square foot (psf) in accordance with NFRC 400, AAMA/WDMA/CSA 101/I.S.2/A440, or ASTM E283.

b. 0.04 cfm/ft^2 for curtain wall and storefront ((~~glazing~~))fenestration, tested at a pressure of at least 1.57 pounds per square foot (psf) in accordance with NFRC 400, AAMA/WDMA/CSA 101/I.S.2/A440, or ASTM E283.

c. 0.2 cfm/ft^2 for all other products when tested at a pressure of at least 1.57 pounds per square foot (psf) in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440, or 0.3 cfm/ft^2 when tested at a pressure of at least 6.24 pounds per square foot (psf) in accordance with AAMA/WDMA/CSA 101/I.S/A440.

EXCEPTIONS:

1. Openings that are required to be fire resistant.

2. Field-fabricated fenestration and doors that are weather-stripped or sealed in accordance with Section 1314.1. A field-fabricated fenestration product is a fenestration product including a glazed exterior door whose frame is made at the construction site of standard dimensional lumber or other materials that were not previously cut, or otherwise formed with the specific intention of being used to fabricate a fenestration product or exterior door. Field-fabricated does not include curtain walls.

3. For garage doors, air leakage determined by test at standard test conditions in accordance with ANSI/DASMA 105 shall be an acceptable alternate for compliance with air leakage requirements.

4. Units without air leakage ratings produced by small business that are weatherstripped or sealed in accordance with Section 1314.1.

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1314.6 Continuous Air Barrier: For all buildings ((~~over five stories~~)), the building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, or out of, the conditioned space. All air barrier components of each envelope assembly shall be clearly identified on construction documents and the joints, interconnections and penetrations of the air barrier components shall be detailed.

Construction documents shall also 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.

Informative Note: As stated above, the continuous air barrier is intended to control the air leakage into and out of the conditioned space. The definition of conditioned space includes

semiheated spaces and indirectly conditioned 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.

The air leakage test is done using calibrated fans. The amount of airflow in cfm (as adjusted for temperature and pressure) at 75 Pa (0.3" w.g.) measured during the test is divided by the area of the building envelope (the pressure boundary) included in the test. Multiplying that building envelope area by 0.4 cfm will provide an indication of how many cfm are needed to perform the test (how many fans or fan capacity).

1314.6.1 Characteristics: The continuous air barrier shall have the following characteristics:

a. The air barrier component of each assembly shall be joined and sealed in a flexible manner to the air barrier component of adjacent assemblies, allowing for the relative movement of these assemblies and components. This requirement shall not be construed to restrict the materials or methods by which the air barrier is achieved.

b. It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the air barrier without damage or displacement, and shall transfer the load to the structure. It shall not displace adjacent materials under full load.

c. It shall be installed in accordance with the manufacturer's instructions and in such a manner as to achieve the performance requirements.

1314.6.2 Compliance: Compliance of the continuous air barrier for the ((~~opaque~~)) building

envelope shall be demonstrated by testing the completed building and demonstrating that the upper 95% confidence interval for the air leakage rate of the building envelope does not exceed 0.40 cfm/ft^2 at a pressure differential of 0.3 inch w.g. (1.57 psf) as specified below.

a. Whole building testing shall be accomplished in accordance with ASTM E 779 or approved similar test. Tests shall be accomplished using either (1) both pressurization and depressurization or (2) pressurization alone, but not depressurization alone((~~or depressurization or both~~)). The building shall not be tested unless it is verified that the continuous air barrier is in place and installed without failures in accordance with installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be done in a timely manner. Following are comments referring to ASTM E 779:

b. Under ASTM E 779 it is permissible to test using the building's HVAC system. In buildings with multistory HVAC systems and shafts it is permissible to test using the building's mechanical system using CAN/CGSB-149.15-96 Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems, Canadian General Standards Board, Ottawa.

c. ((~~In lieu of the fan pressurization method described in ASTM E 779, a tracer gas test of the building air change rate in accordance with ASTM E 741 is also allowed. The tracer gas test shall be run with building HVAC fans off.~~)) Reserved.

d. Section 8.1 - For purposes of this test, a multizone building shall be configured as a single zone by opening all interior doors, and otherwise connecting the interior spaces as much as possible. It is also allowed to test a smaller section of the building, provided the test area can be isolated from neighboring conditioned zones by balancing the pressure in adjacent conditioned zones to that in the zone being tested. This can be very difficult to do in buildings with multistory shafts and HVAC systems. If a smaller section of the building is tested, provide a drawing showing the zone(s) tested, the pressure boundaries and a diagram of the testing equipment configuration.

e. Section 8.2 - Seal all intentional functional openings such as exhaust and relief louvers, grilles and dryer vents that are not used in the test to introduce air, using plastic sheeting and duct tape or similar materials. All plumbing traps shall be filled with water.

f. Section 8.10 - The test pressure range shall be from ((~~10~~)) 25 Pa to 80 Pa((~~. If approved by the building official, lower test pressures are acceptable~~)), but the upper limit shall not be less than 50 Pa, and the difference between the upper and lower limit shall not be less than 25 Pa.

g. Section 9.4 - If both pressurization and depressurization are not tested, plot the air leakage against the corrected P for ((~~either~~)) pressurization((~~ or depressurization~~)).

h. Section 9.6.4 - If the pressure exponent n is less than ((~~0.5~~)) 0.45 or greater than ((~~1~~)) 0.85, ((~~corrective work shall be performed to the continuous air barrier and~~)) the test shall be rerun with additional readings over a longer time interval.

i. Section 10.4 - Report the air leakage rate normalized in cfm/ft^2 at 0.3 inch w.g. (1.57 psf) over the total area of the building envelope air pressure boundary including the lowest floor, any below-grade walls, above-grade walls, and roof (or ceiling) (including windows and skylights) separating the interior conditioned space from the unconditioned environment.

Informative Note: Those familiar with building air leakage testing indicate that there are three critical areas:
- the junctions at the top of the building between interior and exterior walls and the roof;
- the wall areas around the perimeter of the windows (not the windows themselves); and
- brackets and other penetrations used to support exterior features such as awnings and canopies.

For buildings with excessive air leakage, there is a methodology to determine air leakage pathways: ASTM E 1186-03 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

1314.6.3 Certificate of Occupancy: A final certificate of occupancy shall not be issued for the building, or portion thereof, until such time that the building official determines that the project complies with one of the following:

a. Option 1:

i. the continuous air barrier has been inspected by a qualified person (such as the designer or a building commissioning agent) who is not associated with the construction company and an inspection report by that person has been submitted to the building official; and

ii. the building, or portion thereof, has been field tested in accordance with Section 1314.6.2, and the test report for the whole building air leakage testing in accordance with Section 1314.6.2 is provided to DPD and filed with the inspection record for the project.

Informative Note: Option 1 does not require that testing achieve 0.40 cfm/ft^2. The requirement is that the testing be executed in accordance with Section 1314.6.2.

b. Option 2:

i. the building, or portion thereof, has been field tested in accordance with Section 1314.6.2 and the building air leakage does not exceed that allowed in Section 1314.6.2.

Informative Note: As of 2009, the U.S. Army Corps of Engineers limits air leakage in its facilities to 0.25 cfm/ft^2 for mold prevention and so as to reduce energy use in accordance with the 2005 U.S. Energy Policy Act. Tested buildings have been in the range of 0.16-0.25 cfm/ft^2. Their experience is that few buildings have to be sealed and re-tested to meet these requirements when buildings are designed and constructed with attention to details.

For further information on comparisons of building envelope air leakage standards and test procedures, see "U.S. Army Corps of Engineers Air Leakage Protocol for Measuring Air Leakage in Buildings", "Controlling Air Leakage in Tall Buildings" by Colin Genge, ASHRAE Journal, April 2009, pages 50-60, and "Protocol for Field Testing of Tall Buildings to Determine

Envelope Air Leakage Rate" by William Bahnfleth, Grenville Yuill, and Brian Lee, ASHRAE Transactions 1999, V. 105, Pt. 2.

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1314.7 Vestibules. Building entrances that separate conditioned space from the exterior shall be enclosed vestibules, 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. Interior and exterior doors shall have a minimum distance between them of not less than 7 ft and a maximum distance of not more than 20 ft when in the closed position. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space. Either the interior or exterior envelope of unconditioned vestibules shall comply with the requirements for a conditioned space. The building lobby is not considered a vestibule.

EXCEPTIONS:

1. Building entrances with revolving doors.
2. Doors not intended to be used as a building entrance.
3. Building entrances in buildings that are less than four stories above grade and less than 10,000 ft^2 in area.
4. Doors that open directly from a space that is less than 3,000 ft^2 in area and is separate from the building entrance.
5. Entrances to semi-heated spaces.
6. Elevator doors in parking garages provided that the elevators have an enclosed lobby at each level of the garage.

Informative Note: Building entrances are defined as the means ordinarily used to gain access to the building, so this does not include the handicapped access doors that might be adjacent to a revolving door.

Doors other than for building entrances, such as those leading to service areas, mechanical rooms, electrical equipment rooms, or exits from fire stairways, are not covered by this requirement. There is less traffic through these doors and the vestibule may limit access for large equipment.

Enclosed lobbies in parking garages also serve to reduce the flow of vehicle exhaust into the building.

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1321 General: This section establishes building envelope design criteria in terms of prescribed requirements for building construction. Compliance shall be calculated separately for the building envelope for nonresidential spaces and for residential spaces.

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1322 Opaque Envelope: Roof/ceilings, opaque exterior walls, opaque doors, floors over unconditioned space, below-grade walls, slab-on-grade floors and radiant floors enclosing conditioned spaces shall be insulated according to Section 1311 and Tables 13-1 or 13-2. Compliance with nominal R-values shall be demonstrated for the thermal resistance of the added insulation in framing cavities and/or insulated sheathing only. Nominal R-values shall not include the thermal transmittance of other building materials or air films.

For walls where the proposed assembly would not be continuous insulation, Table 13-1 contains two alternate nominal R-value compliance options for assemblies with isolated metal penetrations of otherwise continuous insulation. These alternate nominal R-value compliance options are allowed for projects complying with all of the following:

a. The ratio of the cross-sectional area, as measured in the plane of the wall, of metal penetrations of otherwise continuous insulation to the overall opaque wall area is:

i. less than 0.0004 (less than 0.04%).

ii. less than 0.0008 (less than 0.08%).

b. 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.

c. Every wall assembly shall comply with the alternate nominal R-value compliance option, regardless of where the metal penetrations are located. All wall assemblies (e.g. mass, steel-framed, wood-framed) shall comply with the option in Table 13-1 corresponding to the cross-sectional area of metal penetrations as a percentage of the overall opaque wall area.

d. 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 1332 for determination of U-factors for assemblies that include metal other than screws and nails.

For the U-factor compliance for all envelope components, including metal frame assemblies ((~~used in spaces with electric resistance space heat~~)), compliance shall be demonstrated with the component U-factor for the overall assembly based on the assemblies in Chapter 10.

Area-weighted averaging of the R-value is not allowed. When showing compliance with R-values, the minimum insulation R-value for all areas of the component shall comply with Tables 13-1 and 13-2. When calculating compliance using U-factors, area-weighted averaging is allowed. Where insulation is tapered (e.g. roofs), separate assembly U-factors shall be calculated for each four-foot section of tapered insulation.

EXCEPTIONS:

1. Opaque smoke vents are not required to meet insulation requirements.

2. For roofs with rigid continuous insulation on the top of the roof, the insulation R-value may be averaged for compliance with minimum prescriptive R-values only, provided that both:

   a. the minimum insulation is no less than R-5 (but not including area within 6 inches of each roof drain), and

b. the area-weighted average insulation is R-68 (in lieu of R-38).

Informative Note: For the application of the building envelope requirements to elevator shafts and stair enclosures, see the definition of indirectly conditioned space in Chapter 2.

Informative Note: For the definition of continuous insulation, see Chapter 2.

The alternate nominal R-value compliance options provided in Section 1322 and the default U-factors in Table 10-5A(1) for assemblies with isolated metal penetrations are intended to offer several simple prescriptive choices in lieu of the complicated calculations required to determine the U-factors of assemblies with metal framing.

While specific calculations need to be done for each project, previous calculations have found the following approximate metal penetration area ratios:

- Brick ties alone (that penetrate otherwise continuous insulation) may well have a metal penetration area ratio of 0.0002 (0.02% of the overall opaque wall area).

- Offset brackets alone (that penetrate otherwise continuous insulation) that project out to support a shelf angle (so that the shelf angle does not penetrate otherwise continuous insulation and the insulation can run between the shelf angle and the structure) could have a metal penetration area ratio of 0.0003 (0.03% of the overall opaque wall area).

When added together, the total metal penetration area ratio of otherwise continuous insulation for a design with only these two metal penetration types is likely to be within the range where it could qualify for one of the alternate nominal R-value compliance options.

On the other hand, shelf angles alone (such as those used to support brick veneer) when attached directly to the structure without offset brackets (thereby resulting in the shelf angle penetrating otherwise continuous insulation), such as at the perimeter edge of an intermediate floor slab, are likely to have a metal penetration area ratio in the 0.20% range. Consequently, shelf angles will always need to be mounted on offset brackets that allow insulation to go between

the shelf angle and the primary portions of the wall structure in order to qualify to use one of the alternate nominal R-value compliance options.

As the overall opaque wall area is the basis of the calculation, every wall assembly must comply with the alternate nominal R-value compliance option, regardless of where the metal penetrations are located. Thus, even if the offset brackets attached to the mass wall area were the only metal penetrations (which penetrate otherwise continuous insulation), the infill steel-framed wall or wood-framed wall assemblies would still need to comply with the insulation requirements in the alternate nominal R-value compliance option as the areas of those infill walls were included in the calculation of the metal penetration area ratio.

There also are additional fin effects where the metal contacts the surfaces on the outside of the insulation, such as a brick façade, that have not been considered. Metal cladding would certainly further degrade the effective insulation R-value.

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1323 Fenestration ((~~Glazing~~)). The intent is that fenestration in building facades be designed for daylighting and vary by orientation to respond to external climatic loads. Fenestration ((~~Glazing~~)) shall comply with Section 1312 and Tables 13-1 or 13-2. All glazing shall be, at a minimum, double glazing. In addition, all glazing assemblies shall have at least one low-emissivity coating unless the fenestration((~~glazing~~)) assembly has an overall U-factor that complies with the values in Tables 13-1 or 13-2.

EXCEPTIONS:

1. Vertical fenestration ((~~glazing~~)) located on the display side of the street level story of a retail occupancy or where there is a street level transparency requirement in the Seattle Land Use Code or in parking lot attendant booths with a gross floor area not exceeding 50 square feet provided in each case that the fenestration ((~~glazing~~)):

   a. (i) is double-glazed with a minimum 1/2 inch airspace and with a low-e coating having a maximum emittance of e-0.10 in a nonmetal frame or a metal frame having a thermal break (as defined in footnote 2 to Table 10-6B; or

   (ii) has an area weighted U-factor of 0.50 or less, except that revolving doors and vestibules are allowed to have an area-weighted U-factor of 0.65 or less.

   (U-factor calculations shall use overall assembly U-factors. When this exception is used, there are no SHGC requirements); and

   b. has:

   (i) a visible transmittance for the overall fenestration assembly including the frame of 0.42, or

   (ii) a visible transmittance, determined according to Section 1312.2, Exception 2, for the center of the glazing assembly of 0.48; and,

   c. does not exceed 75 % of the gross exterior wall area of the display side of the street level story measured from the top of the finished floor at street level. However, if the display side of the street level story exceeds 20 feet in height, then this exception may only be used for the first 20 feet of that story.

   When this exception is utilized, separate calculations shall be performed for these sections of the building envelope and these values shall not be averaged with any others for compliance purposes. The 75% area may be exceeded on the street level, if the additional glass area is provided from allowances from other areas of the building.

2. Fenestration with single ((~~Single~~)) glazing for security purposes and in vestibules and revolving doors shall be included in the percentage of the total ((~~glazing~~))fenestration area, U-factor calculation and SHGC as allowed in

the Tables 13-1 or 13-2. The maximum area allowed for the total of all fenestration with single glazing is 1% of the gross exterior wall area.

1323.1 Area: The percentage of total fenestration area (vertical fenestration and skylights) ((~~glazing (vertical and overhead) area~~)) relative to the gross exterior wall area shall not be greater than the appropriate value from Tables 13-1 or 13-2 for the vertical fenestration ((~~glazing~~)) U-factor, ((~~overhead glazing~~))skylight U-factor, ((~~and~~))vertical fenestration solar heat gain coefficient, skylight solar heat gain coefficient, and, where applicable, vertical fenestration visible transmittance selected. For buildings with below-grade wall area, the gross wall area used to calculate the allowable fenestration area shall not include the portion of below-grade walls that is more than 10 feet below grade.

1323.2 U-Factor: The area-weighted average U-factor of vertical fenestration ((~~glazing~~)) shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and solar heat gain coefficient and, where applicable, visible transmittance. The area-weighted average U-factor of skylights((~~overhead glazing~~)) shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and solar heat gain coefficient. U-factors for ((~~glazing~~)) fenestration shall be determined in accordance with Section 1312.

1323.3 Solar Heat Gain Coefficient: The area-weighted average solar heat gain coefficient of ((~~all glazing~~)) fenestration shall be calculated separately for vertical fenestration and for skylights and shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and U-factor and, where applicable, visible transmittance.

EXCEPTIONS:

1. Fenestration ((~~Glazing~~)) separating conditioned space from semi-heated space or unconditioned space.
2. Vertical fenestration with a north orientation ((~~glazing which is oriented within 45 degrees of north~~)) shall be allowed to have a maximum solar heat gain coefficient SHGC-0.10 above that required in Tables 13-1 and 13-2.

When this exception is utilized, separate calculations shall be performed for this vertical fenestration and these values shall not be averaged with any others for compliance purposes.

3. For demonstrating compliance for vertical fenestration ((~~glazing~~)) for the first SHGC option in Tables 13-1 and 13-2 only, the SHGC in the proposed building shall be allowed to be reduced by using the multipliers in the table below for each fenestration ((~~glazing~~)) product shaded by permanent projections that will last as long as the building itself. Permanent projections consisting of open louvers shall be considered to provide shading, provided that no sun penetrates the louvers during the peak sun angle on June 21. For demonstrating compliance for vertical fenestration shaded by partially opaque permanent projections (e.g., framing with glass or perforated metal) that will last as long as the building itself, the PF shall be reduced by multiplying it by a factor that accounts for the solar transmittance.

Projection Factor	SHGC Multiplier (All Orientations except North-oriented)	SHGC Multiplier (North-Oriented)
0 - 0.10	1.00	1.00
<0.10 - 0.20	0.91	0.95
<0.20 - 0.30	0.82	0.91
<0.30 - 0.40	0.74	0.87
<0.40 - 0.50	0.67	0.84
<0.50 - 0.60	0.61	0.81
<0.60 - 0.70	0.56	0.78
<0.70 - 0.80	0.51	0.76

<0.80 - 0.90	0.47	0.75
<0.90 - 1.00	0.44	0.73

Projection factor (PF) is the ratio of the horizontal depth of the external shading projection (A) divided by the sum of the height of the fenestration and the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection (B), in consistent units. (See Figure 13B.)

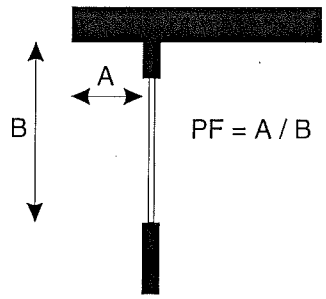

Figure 13B

Informative Note: The projection factor multiplier is used to adjust the SHGC in the proposed design for purposes of Exception 3 above. The SHGC criteria in Table 13-1 do not change.

For example, for a building with a 27% fenestration area, the SHGC required in Table 13-1 for vertical fenestration is SHGC-0.35 maximum.

As a simple example, if the proposed building had vertical fenestration only on the south side of the building and all the fenestration had an NFRC-certified SHGC-0.45, then the fenestration alone would not comply with the maximum SHGC criteria for vertical fenestration. However, if there were an overhang projecting out over the vertical fenestration a distance A of two feet, and the vertical height from the bottom of the window to the bottom of the tip of the overhang were a distance B of six feet, then the projection factor (PF) would be = A/B = 2 ft/6 ft = 0.33.

From the table to Exception 3 above, the multiplier is 0.74 for a 0.33 PF for south-oriented windows. For compliance purposes, SHGC-0.45 x 0.74 multiplier = 0.33 adjusted SHGC. Therefore, the vertical fenestration in the proposed design complies with the SHGC criteria provided this overhang is installed.

Note that for most projects, use of this exception is more complicated. Calculations must be done separately for each window with a different SHGC and with a different overhang A or different height B that changes the projection factor, and for each orientation as north-oriented fenestration has a different multiplier.

1323.4 Visible Transmittance: The area-weighted average visible transmittance of all vertical fenestration shall not be greater than that specified in Table 13-1 for the appropriate area.

***

1331 General: Buildings or structures whose design heat loss rate (UA_p) and solar heat gain coefficient rate (SHGC * A_p) are less than or equal to the target heat loss rate (UA_t) and solar heat gain coefficient rate (SHGC * A_t) shall be considered in compliance with this section. The stated U-factor, F-factor or allowable area of any component assembly, listed in Tables 13-1 or 13-2, such as roof/ceiling, opaque wall, opaque door, vertical fenestration, skylight ((~~glazing~~)), floor over conditioned space, slab-on-grade floor, radiant floor or opaque floor may be increased and the U-factor or F-factor for other components decreased, provided that the total heat gain or loss for the entire building envelope does not exceed the total resulting from compliance to the U-factors, F-factors or allowable areas specified in this section. Compliance shall be calculated separately for the building envelope for nonresidential spaces and for residential spaces.

EXCEPTIONS:

1. Compliance is also allowed to be shown using RS-32 for Climate Zone 1 except

a. for buildings using footnote 2 to Table 13-1 ((~~containing attic roofs, wood framed walls or vertical fenestration with nonmetal frames, or~~)) and

b. for Group R occupancies.

2. The prescriptive approach in Section 1323 may be used for that portion of the building envelope that complies with Exception 1 to Section 1323.

1332 Component U-factors. The U-factors for typical construction assemblies are included in Chapter 10. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 10, values shall be calculated in accordance with Chapters 16 through 18 and 25 through 27 in Standard RS-1 listed in Chapter 7, using the framing factors listed in Chapter 10.

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. Standard RS-1, listed in Chapter 7, where the metal framing is bonded on one or both sides to a metal skin or covering.
3. The zone method as provided in Chapter 27 of Standard RS-1, listed in Chapter 7.
4. Effective framing/cavity R-values as provided in Table 10-5A(2).
5. Mass wall assemblies having exterior insulation with isolated metal penetrations (such as offset brackets supporting shelf angles that allow insulation to go between the shelf angle and the primary portions of the mass wall structure) where the ratio of the cross-sectional area of metal penetrations of otherwise continuous insulation to the mass wall area only is less than 0.0004 (less than 0.04% of the mass wall area only), it is acceptable to use the U-factors shown in Table 10-5B(3) for assemblies with 1 inch metal clips at 24 inches on

center horizontally and 16 inches on center vertically. When this option is used, building permit drawings shall contain a detail showing the offset bracket with the insulation passing between the shelf angle and the primary portions of the mass wall structure. In addition, calculations shall be provided showing the ratio of the cross-sectional area of metal penetrations to the mass wall area.

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

1. For thermal transmittance purposes, not include the ceiling proper nor the plenum space as part of the assembly; and
2. For gross area purposes, be based upon the interior face of the upper plenum surface.

Informative Note: For further information about compliance for assemblies with isolated metal penetrations, see Section 1322 and the default U-factors in Table 10-5A(1).

1333 UA Calculations: The target UA_t and the proposed UA_p shall be calculated using Equations 13-1 and 13-2 and the corresponding areas and U-factors from Table 13-1 or 13-2. For the target UA_t calculation, the ((~~overhead glazing~~))skylights shall be located in roof/ceiling area and the remainder of the ((~~glazing~~))fenestration allowed per Table 13-1 or 13-2 shall be located in the wall area. Where insulation is tapered, separate assembly U-factors shall be calculated in accordance with Section 1322. (See also the criteria in Section 1331.)

Informative Note: For the application of the building envelope requirements to elevator shafts and stair enclosures, see the definition of indirectly conditioned space in Chapter 2.

Procedural Requirement: The plans shall contain a fenestration and opaque door schedule.

The fenestration schedule shall include all vertical fenestration and skylights (curtain walls, windows, sliding and swinging glass doors and glazed roll-up doors, glass block, plastic panels, clerestories, skylights, etc.), as well as all opaque doors (swinging metal egress doors, roll-up warehouse doors, etc.).

For all projects, the fenestration and opaque door schedule shall include the manufacturer and model number for all products regardless of U-factor.

The fenestration and opaque door schedules shall include the product type, size, number of each type, the U-factor and whether the U-factor is NFRC-certified or default.

If the product is claimed to be NFRC-certified, the NFRC Certified Products Directory (CPD) number shall be provided. A simulation report is not acceptable as this does not demonstrate that the product complies with the NFRC rating, labeling, and certification program. Also, a specification sheet that states "determined in accordance with NFRC 100" does not suffice.

For site-built fenestration products (as defined by NFRC) ONLY, at the time of building permit application, it is acceptable to provide simulation reports from an NFRC-accredited simulation laboratory for each product type that is to be installed in the project. The simulation must include the specific frame profiles, glazing options, gas fills, spacers, etc. that are proposed to be installed in the building. However, the NFRC Label Certificate is required to be provided to the building inspector at the construction site. (AAMA 507 reports, thermal performance matrices, and certificates of compliance are not acceptable.)

If a default U-factor from Chapter 10 is used for unrated products in lieu of NFRC certification, the fenestration and opaque door schedule shall include a description of the key energy-efficiency features that are necessary to achieve that default U-factor (indicating whether the fenestration product is fixed or operable, frame material type, thermal break description, number of glazing layers, emissivity of low-e coatings, gap width, gas fill, spacer, type, etc.).

For fenestration in nonresidential spaces, the fenestration schedule shall also include the solar heat gain coefficient for each product and, where applicable, visible transmittance.

1334 Solar Heat Gain Coefficient Rate Calculations: Solar heat gain coefficient shall comply with Section 1323.3. The target $SHGCA_t$ and the proposed $SHGCA_p$ shall be calculated using Equation 13-3 and 13-4 and the corresponding areas and SHGCs from Table 13-1 or 13-2. The target SHGC is the SHGC from Table 13-1 without the projection factor.

1335 Visible Transmittance Calculations:

Visible transmittance rate shall comply with Section 1323.4. The target VTA_t and the proposed VTA_p shall be calculated using Equations 13-5 and 13-6 and the corresponding areas and VTs from Table 13-1.

Informative Note: There is no visible transmittance requirement or calculations required to show code compliance when the proposed total fenestration (vertical and overhead) area relative to the gross exterior wall area is in the 0-30% category of Table 13-1.

EQUATION 13-1

Target UA_t

$$UA_t = U_{radt}A_{radt} + U_{mrt}A_{mrt} + U_{rst}A_{rst} + U_{ort}A_{ort} + U_{ogcort}A_{ogcort} + U_{ogort}A_{ogort} + U_{mwt}A_{mwt} + U_{mbwt}A_{mbwt} + U_{sfwt}A_{sfwt} + U_{wt}A_{wt} + U_{vgt}A_{vgt} + U_{vgmt}A_{vgmt} + U_{vgdt}A_{vgdt} + U_{dt}A_{dt} + U_{fmt}A_{fmt} + U_{fst}A_{fst} + U_{ft}A_{ft} + F_{st}P_{st} + F_{rst}P_{rst}$$

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

Where:

U_{radt} = The thermal transmittance value for roofs with the insulation entirely above deck found in Table 13-1 or 13-2.

U_{mrt} = The thermal transmittance value for metal building roofs found in Table 13-1 or 13-2.

U_{rst} = The thermal transmittance value for single rafter roofs found in Table 13-1 or 13-2.

U_{ort} = The thermal transmittance value for attic and other roofs found in Table 13-1 or 13-2.

U_{ogcort} = The thermal transmittance for ((~~overhead glazing~~))skylights with curb found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area.

U_{ogort} = The thermal transmittance for ((~~overhead glazing~~))skylights without curb found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area.

U_{mwt} = The thermal transmittance value for opaque mass walls found in Table 13-1 or 13-2.

U_{mbwt} = The thermal transmittance value for opaque metal building walls found in Table 13-1 or 13-2.

U_{sfwt} = The thermal transmittance value for opaque steel framed walls found in Table 13-1 or 13-2.

U_{wt} = The thermal transmittance value for opaque wood framed and other walls found in Table 13-1 or 13-2.

U_{vgt} = The thermal transmittance value for vertical fenestration((~~glazing~~)) with nonmetal framing found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area.

U_{vgmt} = The thermal transmittance value for vertical fenestration((~~glazing~~)) with metal framing found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area.

U_{vgdt} = The thermal transmittance value for entrance doors found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area.

U_{dt} = The thermal transmittance value for opaque doors found in Table 13-1 or 13-2.

U_{fmt} = The thermal transmittance value for mass floors over unconditioned space found in Table 13-1 or 13-2.

U_{fst} = The thermal transmittance value for steel joist floors over unconditioned space found in Table 13-1 or 13-2.

U_{ft} = The thermal transmittance value for wood framed or other floors over unconditioned space found in Table 13-1 or 13-2.

F_{st} = The F-factor for slab-on-grade floors found in Table 13-1 or 13-2.

F_{rst} = The F-factor for radiant slab floors found in Table 13-1 or 13-2.

A_{dt} = The proposed opaque door area, A_d.

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

A_{fst} = The proposed steel joist floor over unconditioned space area, A_{fs}.

A_{ft} = The proposed wood framed and other floor over unconditioned space area, A_f.

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

P_{rst} = The proposed ((~~linear~~)) lineal feet of radiant slab floor perimeter, P_{rs}.

and;

if the total amount of ((~~glazing~~))fenestration area as a percent of gross exterior wall area does not exceed the maximum allowed in Table 13-1 or 13-2:

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

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

A_{rst} = The proposed single rafter roof area, A_{rs}.

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

A_{ogcort} = The proposed ((~~overhead glazing~~))skylight area with curbs, A_{ogcor}.

A_{ogort} = The proposed ((~~overhead glazing~~))skylight area without curbs, A_{ogor}.

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

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

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

A_{wt} = The proposed opaque wood framed and other wall area, A_w.

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

A_{vgmt} = The proposed vertical ((~~glazing~~))fenestration area with metal framing, A_{vgm}.

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

or;

if the total amount of ((~~glazing~~))fenestration area as a percent of gross exterior wall area exceeds the maximum allowed in Table 13-1 or 13-2, the area of each fenestration element shall be reduced in the base envelope design by the same percentage and the net area of each wall type adjusted proportionately by the same percentage so that the total ((~~overhead~~))skylight and vertical fenestration area is exactly equal to the maximum gross wall area allowed in Table 13-1 or 13-2.

EQUATION 13-2

Proposed UA_p

$$UA_p = U_{rad}A_{rad} + U_{mr}A_{mr} + U_{rs}A_{rs} + U_{ra}A_{ra} + U_{ogc}A_{ogc} + U_{og}A_{og} + U_{mw}A_{mw} + U_{mbw}A_{mbw} + U_{sfw}A_{sfw} + U_{wfow}A_{wfow} + U_dA_d + U_{vg}A_{vg} + U_{vgm}A_{vgm} + U_{vgd}A_{vgd} + U_{fm}A_{fm} + U_{fs}A_{fs} + U_{fwo}A_{fwo} + F_sP_s + F_{sr}P_{sr}$$

Where:

UA_p = The combined proposed specific heat transfer of the gross exterior wall, floor and roof/ceiling assembly area.

U_{rad} = The thermal transmittance of the roof area where the insulation is entirely above roof deck.

A_{rad} = Opaque roof area where the insulation is entirely above roof deck.

U_{mr} = The thermal transmittance of the metal building roof area.

A_{mr} = Opaque metal building roof area.

U_{rs} = The thermal transmittance of the single rafter roof area.

A_{rs} = Opaque single rafter roof area.

U_{ra} = The thermal transmittance of the roof over attic and other roof area.

A_{ra} = Opaque roof over attic and other roof area.

U_{ogc} = The thermal transmittance for the ((~~overhead glazing~~))skylights with curbs.

A_{ogc} = ((~~Overhead glazing~~))Skylights area with curbs.

U_{og} = The thermal transmittance for the ((~~overhead glazing~~))skylights without curbs.

A_{og} = ((~~Overhead glazing~~))Skylights area without curbs.

U_{mw} = The thermal transmittance of the opaque mass wall area.

A_{mw} = Opaque mass wall area (not including opaque doors).

U_{mbw} = The thermal transmittance of the opaque metal building wall area.

A_{mbw} = Opaque metal building wall area (not including opaque doors).

U_{sfw} = The thermal transmittance of the opaque steel framed wall area.

A_{sfw} = Opaque steel framed wall area (not including opaque doors).

U_{wfow} = The thermal transmittance of the opaque wood framed and other wall area.

A_{wfow} = Opaque wood framed and other wall area (not including opaque doors).

U_{vg} = The thermal transmittance of the vertical ((~~glazing~~))fenestration area with nonmetal framing.

A_{vg} = Vertical ((~~glazing~~))fenestration area with nonmetal framing.

U_{vgmf} = The thermal transmittance of the vertical ((~~glazing~~))fenestration area with metal framing.

A_{vgmf} = Vertical ((~~glazing~~))fenestration area with metal framing.

U_{vgd} = The thermal transmittance of the vertical ((~~glazing~~))fenestration area for entrance doors.

A_{vgd} = Vertical ((~~glazing~~))fenestration area for entrance doors.

U_d = The thermal transmittance value of the opaque door area.

A_d = Opaque door area.

U_{fm} = The thermal transmittance of the mass floor over unconditioned space area.

A_{fm} = Mass floor area over unconditioned space.

U_{fs} = The thermal transmittance of the steel joist floor over unconditioned space area.

A_{fs} = Steel joist floor area over unconditioned space.

U_{fwo} = The thermal transmittance of the wood framed and other floor over unconditioned space area.

A_{fwo} = Wood framed and other floor area over unconditioned space.

F_s = Slab-on-grade floor component F-factor.

P_s = ((~~Linear~~)) Lineal feet of slab-on-grade floor perimeter.

F_{sr} = Radiant floor component F-factor.

P_{sr} = ((~~Linear~~)) Lineal feet of radiant floor perimeter.

NOTE: Where more than one type of wall, window, roof/ceiling, door and skylight is used, the U and A terms for those items shall be expanded into sub-elements as:

$$U_{mw1}A_{mw1} + U_{mw2}A_{mw2} + U_{sfw1}A_{sfw1} + ...\text{etc.}$$

EQUATION 13-3

Target $SHGCA_t$

$SHGCA_t$ = $SHGC_t (A_{ogcort} + A_{ogort} + A_{vgt} + A_{vgmt} + A_{vgdt})$

((~~$SHGC_t (A_{ograt} + A_{ogort} + A_{vgt})$~~))

Where:

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

$SHGC_t$ = The solar heat gain coefficient for fenestration((~~glazing~~)) found in Table 13-1 or 13-2 which corresponds to the proposed total ((~~glazing~~))fenestration area as a percent of gross exterior wall area, and

A_{ogcort}, A_{ogort}, A_{vgt}, A_{vgmt}, and A_{vgdt} ((~~A_{ograt}, A_{ogort}, and A_{vgt}~~))are defined under Equation 13-1.

EQUATION 13-4

Proposed $SHGCA_p$

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

Where:

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

$SHGC_{og}$ = The solar heat gain coefficient of the ((~~overhead glazing~~))skylights.

A_{og} = The ((~~overhead glazing~~))skylight area.

$SHGC_{vg}$ = The solar heat gain coefficient of the vertical fenestration((~~glazing~~)).

A_{vg} = The vertical ((~~glazing~~))fenestration area.

EQUATION 13-5

Target VTA_t

$VTA_t = VT_tA_{vgt}$

Where:

VTA_t = The target combined visible transmittance of the target fenestration area.

VT_t = The visible transmittance for fenestration found in Table 13-1 which corresponds to the proposed total fenestration area as a percent of gross exterior wall area, and A_{vgt} is defined under Equation 13-1.

EQUATION 13-6

Proposed VTA_p

$VTA_p = VT_{vg}A_{vg}$

Where:

VTA_t = The combined proposed visible transmittance of the proposed fenestration area.

VT_{vg} = The visible transmittance of the vertical fenestration.

A_{vg} = The vertical fenestration area.

TABLE 13-1

BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 1

	Nonresidential		Residential, Other than Single-Family	
Opaque Elements	**Assembly Max. U-factor**	**Insulation Min. R-Value**	**Assembly Max. U-factor**	**Insulation Min. R-Value**
Roofs				
Insulation entirely above deck	U-0.026 ((~~U-0.034~~))	R-38 c.i. ((~~R-30 c.i.~~))	U-0.031	R-38 c.i.

Metal building	U-0.027 ((~~U-0.031~~))	R-25 + R-11 + R-11 Ls	U-0.031	R-25 + R-11 Ls
Single-rafter	U-0.027	R-38	U-0.027	R-38
Attic and other	U-0.027	R-38 adv or R-49	U-0.027	R-38 adv or R-49
Walls, Above Grade				

Mass ((†)) (includes peripheral edges of intermediate floor slabs and columns)	U-0.057 for exterior and integral insulation U-0.056 for interior insulation ((~~U-0.150~~))	Exterior and integral insulation: a. R-16 c.i. b. R-20 insulation with < 0.04% cross-sectional area of metal penetrations per Section 1322. c. R-24 insulation with > 0.04% and < 0.08% cross-sectional area of metal penetrations per Section 1322. Interior insulation: d. R-13 cavity insulation + R-6 c.i. wood studs; or e. R-13 cavity insulation + R-10 c.i. metal studs; or f. R-22.4 insulation held solely by 1-in metal clips. ((~~R-5.7 c.i.~~))	U-0.090	R-11.4 c.i.
Metal building	U-0.052 ((~~U-0.064~~))	R-13 + R-13 c.i. ((~~R-13 + R-7.5 c.i.~~))	U-0.057	R-19 + R-8.5 c.i.

Steel framed	U-0.055 ((~~U-0.064~~))	a. R-13 cavity + R-10 c.i. b. R-13 cavity + R-12.5 insulation with < 0.04% cross-sectional area of metal penetrations per Section 1322. c. R-13 cavity + R-15 insulation with > 0.04% and < 0.08% cross-sectional area of metal penetrations per Section 1322. ((~~R-13 + R-7.5 c.i.~~))	U-0.057	R-19 + R-8.5 c.i.

Wood framed and other	U-0.051 ((~~U-0.057~~))	a. R-13 cavity + R-7.5 c.i. b. R-13 cavity + R-9.4 insulation with < 0.04% cross-sectional area of metal penetrations per Section 1322. c. R-13 cavity + R-11.3 insulation with ≥ 0.04% and < 0.08% cross-sectional area of metal penetrations per Section 1322. ((~~R-21~~))	U-0.057	R-13 + R-6 c.i.
Walls, Below Grade				

Below grade wall	U-0.070	Exterior insulation: a. R-10 c.i. Interior insulation: b. R-19 cavity insulation wood studs; or c. R-13 cavity insulation + R-6 c.i. metal studs; or d. R-16.8 insulation held solely by 1-in metal clips. ((~~Same as above grade~~))		Same as above grade
Floors				
Mass	U-0.029	R-30 c.i.	U-0.029	R-30 c.i.
Steel joist	U-0.029	R-38 cavity + R-4 c.i.	U-0.029	R-38 + R-4 c.i.
Wood framed and other	U-0.025 ((~~U-0.029~~))	R-38 cavity ((~~R-30~~))	U-0.029	R-30
Slab-on-Grade Floors				
Unheated	F-0.520 ((~~F-0.540~~))	((~~R-10~~)) R-15 for 24 in. (with thermal break)	F-0.540	R-10 for 24 in. (with thermal break)
Heated	F-0.360	R-10 c.i. (with thermal break)	F-0.360	R-10 c.i. (with thermal break)
Opaque Doors				

Swinging	U-0.470 ((~~U-0.600~~))		U-0.400	
Nonswinging	U-0.390 ((~~U-0.600~~))		U-0.400	
Fenestration ((~~0-40% of Wall~~))	**Assembly Max. U-Factor NFRC-certified or per 1006**	**Assembly Max. SHGC NFRC-certified or per 1312.1**	**Assembly Max. U-Factor NFRC-certified or per 1006**	**Assembly Max. SHGC NFRC-certified or per 1312.1**
Total fenestration (vertical and overhead) area relative to the gross exterior wall area: 0-30.0% of wall				
Vertical Fenestration				
Nonmetal framing: All	U-0.30 ((~~U-0.32~~))	For all frame types:	U-0.32	
Metal framing: Fixed/operable	U-0.38 [2] ((~~U-0.40~~))	((~~SHGC-0.40~~)) SHGC-0.35 all OR	U-0.40	

Entrance doors (revolving doors & vestibules)	U-0.60 (U-0.65)	SHGC-0.45 all PLUS permanent PF>0.50 on west, south and east	U-0.60	
Skylights				
Without curb (i.e., sloped glazing)	U-0.45 ((~~U-0.50~~))	SHGC-0.32 all[1] ((~~SHGC-0.35 all~~))	U-0.50	SHGC-0.35 all
With curb (i.e., individual unit skylights)	U-0.55 ((~~U-0.60~~))		U-0.60	
Fenestration	**Assembly Max. U-Factor NFRC-certified or per 1006**	**Assembly Max. SHGC & Min. VT NFRC-certified or per 1312.1**	**Assembly Max. U-Factor NFRC-certified or per 1006**	**Assembly Max. SHGC NFRC-certified or per 1312.1**
Total fenestration (vertical and overhead) area relative to the gross exterior wall area: > 30.0 and <40.0% of wall				
Vertical Fenestration				

Nonmetal framing: All	U-0.28	For all frame types:	U-0.32	
Metal framing: Fixed/operable	U-0.38 [2]	SHGC-0.33 all AND minimum VT-0.51 all OR	U-0.40	
Entrance doors (revolving doors & vestibules)	U-0.60 (U-0.65)	SHGC-0.45 all PLUS permanent PF>0.50 on west, south and east AND minimum VT-0.51 all	U-0.60	
Skylights				
Without curb (i.e., sloped glazing)	U-0.40	SHGC-0.30 all[1]	U-0.50	SHGC-0.35 all
With curb (i.e., individual unit skylights)	U-0.50		U-0.60	

c.i. = continuous insulation, Ls = liner system (see definitions). Also see requirements in Section 1332 for methodology for determining U-factors for assemblies containing metal.

Footnotes

1. Daylighting with Plastic Skylights. For plastic skylights, the SHGC is allowed to be SHGC-0.65 maximum provided that:

   (a) the visible transmittance (VT) is greater than the SHGC and

   (b) the skylight area is no greater than 6% of the overhead daylight zone.

((~~Nonresidential walls may be ASTM C90 concrete block walls, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu·in/h·ft^2·°F.~~))

2. In nonresidential spaces, up to 10% of the actual vertical fenestration with metal framing is allowed to be operable fenestration with an area-weighted-average assembly maximum U-Factor (NFRC-certified or default per Section 1006) of U-0.45 provided that:

(a) the total operable fenestration area does not exceed 10% of the total vertical fenestration (actual fixed plus operable) area,

(b) the total fenestration (vertical and overhead) area does not exceed 40% of the gross exterior wall area, and

(c) the building utilizes an HVAC energy management system that notifies building occupants of acceptable time periods (based on outdoor air temperatures) when the operable fenestration may be manually opened for natural ventilation and that disables HVAC operation at the perimeter zones when outdoor air conditions for natural ventilation are met. If approved by the building official, other similar control strategies are allowed to be used where they are shown to reduce the HVAC perimeter zone energy consumption when used in conjunction with natural ventilation from operable fenestration.

This footnote does not apply to fenestration with nonmetal framing. This footnote is not allowed to be used for the RS-29 or RS-32 compliance options.

This footnote is allowed to be used for the Component Performance compliance option in Sections 1330 through 1335 provided that the Proposed Design complies with (a), (b), and (c).

When this footnote is utilized, separate calculations shall be performed for the operable fenestration and these values shall not be averaged with any others for compliance purposes.

Informative Note: For the application of the building envelope requirements to elevator shafts and stair enclosures, see the definition of indirectly conditioned space in Chapter 2.

Informative Note: For further information about compliance for assemblies with isolated metal penetrations, see Section 1322 and the default U-factors in Table 10-5A(1).

Procedural Requirement: The plans shall contain a fenestration and opaque door schedule.

The fenestration schedule shall include all vertical fenestration and skylights (curtain walls, windows, sliding and swinging glass doors and glazed roll-up doors, glass block, plastic panels, clerestories, skylights, etc.), as well as all opaque doors (swinging metal egress doors, roll-up warehouse doors, etc.).

For all projects, the fenestration and opaque door schedule shall include the manufacturer and model number for all products regardless of U-factor.

The fenestration and opaque door schedules shall include the product type, size, number of each type, the U-factor and whether the U-factor is NFRC-certified or default.

If the product is claimed to be NFRC-certified, the NFRC Certified Products Directory (CPD) number shall be provided. A simulation report is not acceptable as this does not demonstrate that the product complies with the NFRC rating, labeling, and certification program. Also, a specification sheet that states "determined in accordance with NFRC 100" does not suffice.

For site-built fenestration products (as defined by NFRC) ONLY, at the time of building permit application, it is acceptable to provide simulation reports from an NFRC-accredited simulation laboratory for each product type that is to be installed in the project. The simulation must include the specific frame profiles, glazing options, gas fills, spacers, etc. that are proposed to be installed in the building. However, the NFRC Label Certificate is required to be provided

to the building inspector at the construction site. (AAMA 507 reports, thermal performance matrices, and certificates of compliance are not acceptable.)

If a default U-factor from Chapter 10 is used for unrated products in lieu of NFRC certification, the fenestration and opaque door schedule shall include a description of the key energy-efficiency features that are necessary to achieve that default U-factor (indicating whether the fenestration product is fixed or operable, frame material type, thermal break description, number of glazing layers, emissivity of low-e coatings, gap width, gas fill, spacer, type, etc.).

For fenestration in nonresidential spaces, the fenestration schedule shall also include the solar heat gain coefficient for each product and, where applicable, visible transmittance.

Section 13. The following sections or subsections of Chapter 14 of the 2009 Washington State Energy Code are amended, and new subsections are added, as follows:

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FIGURE 14A
MECHANICAL SYSTEMS COMPLIANCE PATH

Section Number	Subject	Simple Systems Path	Complex Systems Path	Systems Analysis Option
1410	General Requirements	X	X	X
1411	((~~HVAC~~)) Mechanical Equipment Performance Requirements	X	X	X
1412	Controls	X	X	X
1413	Air Economizers	X	X	X
1414	Ducting Systems	X	X	X

Section Number	Subject	Simple Systems Path	Complex Systems Path	Systems Analysis Option
1415	Piping Systems	X	X	X
1416	Completion Requirements	X	X	X
1420	Simple Systems (Packaged Unitary Equipment)	X		
1421	System Type	X		
1422	Controls	X		
1423	Economizers	X		
1424	Separate Air Distribution Systems	X		
1430	Complex Systems		X	
1431	System Type		X	
1432	Controls		X	
1433	Economizers		X	
1434	Separate Air Distribution Systems		X	
1435	Simultaneous Heating and Cooling		X	
1436	((~~Heat~~)) Energy Recovery		X	
1437	Electric Motor Efficiency		X	
1438	Variable Flow Systems		X	
1439	Exhaust Hoods		X	
RS-29	Systems Analysis			X
1440	Domestic Water Systems	X	X	X
1441	Water Heater Installation	X	X	X
1442	Shut Off Controls	X	X	X
1443	Pipe Insulation	X	X	X

Section Number	Subject	Simple Systems Path	Complex Systems Path	Systems Analysis Option
1444	Conservation of Water and Pumping Energy	X	X	X
1445	Heat Recovery for Domestic Water Systems	X	X	X
1446	Domestic Hot Water Meters	X	X	X
1450	Heated Pools	X	X	X
1451	General	X	X	X
1452	Pool Water Heaters	X	X	X
1453	Controls	X	X	X
1454	Pool Covers	X	X	X
1454	Heat Recovery	X	X	X
1460	Cold Storage	X	X	X
1461	Refrigerated Warehouse Heating and Cooling	X	X	X
1462	Underslab Heating	X	X	X
1463	Evaporators	X	X	X
1464	Condensers	X	X	X
1465	Compressors	X	X	X
1470	Compressed Air and Vacuum Air	X	X	X
1475	Commercial Food Service	X	X	X

***

1402 Mechanical Ventilation: The minimum requirements for ventilation shall comply with the ((~~Washington State Mechanical Code (WAC 51-52)~~)) Seattle Mechanical Code.

1410 General Requirements. The building mechanical system shall comply with Sections 1411 through 1416, Sections 1440 through 1443, Sections 1450 through 1454, Sections 1470 and 1475, and with one of the following paths:

a. Simple Systems (Packed Unitary Equipment), Sections 1420 through 1424

b. Complex Systems, Sections 1430 through 1439

c. Systems Analysis. See Section 1141.4

Systems serving cold storage spaces and frozen storage spaces in refrigerated warehouses shall meet the requirements of Sections 1416, 1437, and 1460 through 1465.

1411 ((~~HVAC~~)) Mechanical Equipment Performance Requirements.

> Informative Note: As indicated in Section 1120, the Energy Code applies to industrial facilities, as well as commercial and industrial processes. Thus, the equipment efficiency requirements apply to industrial facilities, as well as systems and equipment used in commercial and industrial processes.

1411.1 General: Equipment shall have a minimum performance at the specified rating conditions not less than the values shown in Tables 14-1A through 14-1G. Air conditioners primarily serving computer rooms and covered by ASHRAE Standard 127 shall comply with the requirements in Table 14-1A(2). All other air conditioners shall comply with the requirements in Table 14-1A(1). If a nationally recognized certification program exists for a product covered in Tables 14-1A through14-1G, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program.

Informative Note: The AHRI certification program is nationally recognized and it does include provisions for verification and challenge of equipment efficiency ratings. Consequently, if equipment is subject to an AHRI Standard, it shall be listed in the AHRI certification program.

For equipment not within the scope of the standards in Table 14-1A through 14-1G, this Code does not contain any minimum efficiency requirements. However, for any claims of efficiency, such as for calculations using the RS-29 compliance option, data shall be furnished by the equipment manufacturer consisting of a complete report from a test performed by an independent laboratory accredited by a nationally recognized accreditation organization.

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

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

EXCEPTIONS:

1. Where the designer demonstrates that the water quality at the building site fails to meet manufacturer's specifications for the use of water-cooled equipment.
2. Air-cooled chillers with minimum efficiencies at least 10 percent higher than those listed in Table 14-1C.
3. Replacement of existing equipment.

Cooling towers serving chilled water systems shall be selected to be able to maintain a

return condenser water temperature to the tower of 86°F or less at peak design conditions, except for replacement cooling towers of the same or smaller capacity in existing buildings where physical constraints preclude a change from the original design.

Hydronic heat pump and other cooling and refrigeration equipment (e.g. icemakers, walk-in coolers) shall not use domestic water only one time before dumping it to waste (no single pass water cooling systems are allowed). The only exceptions are: replacement of existing icemakers; or use of single pass cooling for medical and dental equipment during power outages and other emergencies.

1411.2 Rating Conditions: Cooling equipment shall be rated at AHRI test conditions and procedures when available. If equipment is rated in accordance with an AHRI Standard, it shall be rated at AHRI Standard Rating Conditions, not "design" conditions. Where no applicable procedures exist, data shall be furnished by the equipment manufacturer consisting of a complete report from a test performed by an independent laboratory accredited by a nationally recognized accreditation organization.

1411.2.1 Water-Cooled Centrifugal Water-Chilling Packages--Nonstandard Conditions: Water-cooled centrifugal water-chilling packages that are not designed for operation at AHRI Standard 550/590 test conditions reflected in Table 14-1C (44°F leaving chilled-water temperature and 85°F entering condenser water temperature with 3 gpm/ton condenser water flow) shall have maximum full-load kW/ton and NPLV ratings adjusted using Equation 14-1.

The adjusted full load and NPLV values are only applicable over the following full-load design ranges:

- Minimum leaving chilled water temperature: 38°F;
- Maximum condenser entering water temperature: 102°F;
- Condenser water flow: 1 to 6 gpm/ton; and

- $X > 39$ and < 60.

Chillers designed to operate outside of these ranges or applications utilizing fluids or solutions with secondary coolants (e.g., glycol solutions or brines) with a freeze point of 27°F or lower from freeze protection are not covered by this standard.

EQUATION 14-1

Adjusted maximum full-load kW/ton rating = (Full load kW/ton from Table 14-1C)/K_{adj}

Adjusted maximum NPLV rating = (IPLV from Table 14-1C)/K_{adj}

Where:

K_{adj} = $6.174722 - 0.303668(X) + 0.00629466(X)^2 - 0.000045780(X)^3$

X = $DT_{std} + LIFT$

DT_{std} = (24 + [full load kW/ton from Table 14-1C] x 6.83)/Flow

Flow = Condenser water flow (gpm)/cooling full load capacity (tons)

LIFT = CEWT - CLWT

CEWT = Full load condenser entering water temperature (°F)

CLWT = Full load condenser leaving chilled water temperature (°F)

***

1411.4 Packaged <u>and Split System</u> Electric Heating and Cooling Equipment:

Packaged and split system electric equipment providing both heating and cooling, and cooling only equipment with electric heat in the main supply duct before VAV boxes, in each case with a total cooling capacity greater than 20,000 Btu/h, shall be a heat pump.

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

Informative Note: This does not apply to VAV systems with terminal reheat provided that there is no electric heat in the main supply duct. Electric heat is allowed in the terminal units.

***

1412.4 Setback and Shutoff: HVAC systems shall be equipped with automatic controls capable of accomplishing a reduction of energy use through control setback or equipment shutdown during periods of nonuse or alternate use of the spaces served by the system. The automatic controls shall:

a. Have a minimum seven-day clock and be capable of being set for seven different day types per week,

b. Be capable of retaining programming and time setting during loss of power for a period of at least ten hours, and

c. Include an accessible manual override, or equivalent function (e.g., telephone interface), that allows temporary operation of the system for up to two hours.

EXCEPTIONS:

1. Systems serving areas which require continuous operation at the same temperature setpoint.

2. Equipment with full load demands of 2 Kw (6,826 Btu/h) or less may be controlled by readily accessible manual off-hour controls.

3. Systems controlled by an occupant sensor that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.

4. Systems controlled solely by a manually operated timer capable of operating the system for no more than two hours.

For hotel and motel guest rooms, a minimum of one of the following control technologies shall be required in hotels/motels with over 50 guest rooms such that the space temperature would automatically setback (winter) or set up (summer) by no less than 3°C (5°F) when the occupant is not in the room:

1. Controls that are activated by the room occupant via the primary room access method - key, card, deadbolt, etc.

2. Occupancy sensor controls that are activated by the occupant's presence in the room.

1412.4.1 Dampers: Outside air intakes, exhaust outlets and relief outlets serving conditioned spaces shall be equipped with motorized dampers which close automatically when the system is off or upon power failure. Return air dampers shall be equipped with motorized dampers. Stair shaft and elevator shaft smoke relief openings shall be equipped with normally open (fails to open upon loss of power) dampers. These dampers shall remain closed until activated by the fire alarm system or other approved smoke detection system.

EXCEPTIONS:

1. Systems serving areas which require continuous operation.

2. Combustion air intakes.

3. Gravity (nonmotorized) relief dampers are acceptable in systems with a design outdoor air intake or exhaust capacity of 300 cfm or less((~~equipment with less than cfm 5,000 cfm total supply flow when in buildings less than 3 stories in height~~)).

4. Type 1 grease hoods exhaust.

Informative Note: Per RS-9, Section 6.5.1.1.5, relief dampers are part of an air economizer system that prevents overpressurization of the building. Other exhausts are not considered relief and require motorized dampers.

Dampers installed to comply with this section, including dampers integral to HVAC equipment, shall have a maximum leakage rate when tested in accordance with AMCA Standard 500 of:

(a) Motorized dampers: 10 cfm/ft^2 of damper area at 1.0 in w.g.

(b) Nonmotorized dampers: 20 cfm/ft^2 of damper area at 1.0 in w.g., except that for nonmotorized dampers smaller than 24 inches in either dimension: 40 cfm/ft^2 of damper area at 1.0 in w.g.

Drawings shall indicate compliance with this section.

1412.4.1.1 Damper Controls: Dampers for outdoor air supply and exhaust shall automatically shut when the systems or spaces served are not in use or during building warm-up, cooldown, and setback. Operation of dampers shall be allowed during ventilation prepurge one hour before expected occupancy and for unoccupied period precooling during the cooling season.

Classrooms, gyms, auditoriums and conference rooms larger than 500 square feet of floor area shall have occupancy sensor control that will either close outside air dampers or turn off serving equipment when the space is unoccupied except where equipped with another means to automatically reduce outside air intake below design rates when spaces are partially occupied.

1412.4.2 Optimum Start Controls: Heating and cooling systems with design supply air capacities exceeding 2,000 cfm shall have optimum start controls. Optimum start controls shall be designed to automatically adjust the start time of an HVAC system each day to bring the space

to desired occupied temperature levels immediately before scheduled occupancy. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint and the amount of time prior to scheduled occupancy.

***

1412.5 Heat Pump Controls: ((~~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.~~)) Heat pumps with supplementary electric resistance heaters shall have controls complying with the following requirements:

1. Prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
2. The cut-on temperature for compression heating shall be higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compressing heating shall be higher than the cut-off temperature for supplementary heating.

All heat pumps installed shall include the capability to lock out the supplementary heat based on outdoor temperature. This control shall have a maximum setting of 40°F. At final inspection, the lock out control shall be set to 32°F or less.

EXCEPTION: The controls may allow supplementary heater operation during defrost.

***

1412.8 Demand Control Ventilation.

1412.8.1 Ventilation Controls for High-Occupancy Areas. Demand control ventilation (DCV) is required for spaces that are larger than 500 ft^2, have an occupant density for ventilation of greater than 25 people per 1000 ft^2 of floor area (based on the Default Occupant Density column of Table 403.3 of the ((~~Washington State~~)) Seattle Mechanical Code), and are served by systems with one or more of the following:

a. An air-side economizer,

b. Automatic modulating control of the outdoor air damper, or

c. A design outdoor ventilation airflow of all systems serving the space combined greater than 3000 cfm.

EXCEPTIONS:

1. Systems with energy recovery complying with Section 1436.

2. Spaces with a combined design outdoor airflow less than 1000 cfm.

3. Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1000 cfm.

1412.8.2 Ventilation Controls for Laboratories. Demand-based ventilation control or setback control of ventilation is required for laboratory spaces with a design air change rate greater than or equal to 6 air changes per hour (ACH). The system shall be capable of reducing the ventilation to 3 ACH.

1412.9 Enclosed Loading Dock, ((~~and~~)) Parking Garage, and Motor Vehicle Repair Garage Exhaust Ventilation System Control. Mechanical ventilation systems for enclosed loading docks, ((~~and~~)) parking garages, and motor vehicle repair garages shall be designed to exhaust the

airflow rates (maximum and minimum) determined in accordance with the ((~~State Mechanical Code (chapter 51-52 WAC)~~)) Seattle Mechanical Code Section 404.

((~~Ventilation systems shall be equipped with a control device that operates the system automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices. Each of the following types of controllers shall be capable of shutting off fans or modulating fan speed.~~)) Mechanical ventilation systems shall operate continuously to provide ventilation per Seattle Mechanical Code Section 404.2.

1. Gas sensor controllers shall be arranged to operate automatically upon detection of vehicle operation or the presence of occupants by approved automatic detection devices and shall be equipped with gas-sensor systems that modulate the ventilation system by staging fans or varying fan speed to maintain gas concentrations below specified maximum levels ((~~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 following are minimum gas sensor system requirements:

   a. ((~~Garages and~~)) In enclosed loading docks, parking garages, and motor vehicle repair garages used predominantly by gasoline-powered vehicles 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). Spacing and location of the sensors shall be installed in accordance with manufacturer recommendations.

   b. In enclosed loading docks, parking garages, and motor vehicle repair garages ((W))where more than 20 percent of the vehicles using the garage or loading dock are powered by nongasoline fuels, the area exposed to nongasoline fueled vehicle exhaust

shall be equipped with a controller and fuel-appropriate sensors. The set-point for the nongasoline sensors shall be no less than the standard used by OSHA for eight hour exposure. The controller shall activate the ventilation system when sensor set-point is reached. Spacing and location of the sensors shall be installed in accordance with manufacturer recommendations.

2. Automatic time clocks used to activate the system shall activate the system during occupied periods. The time clock shall be capable of scheduling multiple start and stop times for each day of the week, varying the daily schedule, and retaining programming for a 10-hour period during loss of power.

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

1412.9.1 System Activation Devices for Enclosed Loading Docks. Ventilation systems for enclosed loading docks shall operate continuously and shall be staged or vary fan speed by gas sensors.

EXCEPTION: Enclosed loading docks, having a total design capacity less than 3000 cfm, are permitted to use occupant sensors or time clocks with a manual over-ride switch. Ready access to the switch shall be provided to persons in the loading dock area. Time clocks shall activate the system during occupied periods and shall be capable of scheduling multiple start and stop times for each day of the week, varying the daily schedule, and retaining programming for 10 hours during loss of power.

((~~be activated by one of the following:~~

~~1. Gas sensors; or~~

~~2. Time clock and a manual over-ride switch located in the dock area that is accessible to persons in the loading dock area.~~))

1412.9.2 System Activation Devices for Enclosed Parking Garages. Ventilation systems for enclosed parking garages shall operate continuously and shall be staged or vary fan speed by gas sensors.

EXCEPTIONS:

1. Enclosed parking garages or motor vehicle repair garages having a total design capacity less than 6,000 cfm are permitted to use either of the following:

   a. An automatic time clock that activates the system during occupied periods that is capable of scheduling multiple start and stop times for each day of the week, varying the daily schedule, and retaining programming for 10 hours during loss of power.

   b. An occupant detection sensor that activates the system when entry into the parking garage along a vehicle or pedestrian pathway is detected.

2. For enclosed parking garages that are routinely closed to vehicle traffic the garage ventilation system can be shut down during periods when the garage is not scheduled to be open provided that the all of the following conditions are met:

   a. Enclosed parking garage has a total coverage gas detection system,

   b. Gas detection system is continuously active to stage fans or vary fan speed to maintain specified gas concentration levels below specified maximum levels, and

   c. System operates for a minimum of 1-hour after the garage is scheduled to be closed.

For purposes of this section, enclosed parking garages that are routinely closed to vehicle traffic are defined as commercial parking structures that have posted closed hours including commercial garages that have irregular hours due to events. Enclosed parking garages that serve multifamily residential, garages that are open 24 hours per day for 7 days per week, or other similar uses are not considered to be defined as routinely closed to vehicle traffic.

((~~be activated by gas sensors.~~

~~**EXCEPTION:** A parking garage ventilation system having a total design capacity under 8,000 cfm may use a time clock or occupant sensors.~~))

1412.9.3 System Activation Devices for Enclosed Motor Vehicle Repair Garages. Ventilation systems for enclosed motor vehicle repair garages shall operate continuously and shall be staged or vary fan speed by gas sensors.

EXCEPTION: Motor vehicle repair garages are permitted to shutdown during periods when the garage is closed provided there is a manual override switch for garage employees to enable the system after hours and the gas detection system is continuously active to stage fans or vary fan speed to maintain specified gas concentration levels below specified maximum levels.

1412.10 Single Zone Variable-Air-Volume Controls. HVAC systems shall have variable airflow controls as follows:

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

1. One half of the full fan speed, or

2. The volume of outdoor air required to meet the ventilation requirements of the Seattle Mechanical Code.

b. Effective January 1, 2012, all air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity, at the rating conditions in the AHRI standard appropriate to the equipment, greater than or equal to 110,000 Btu/h that serve single zones shall have their supply fans controlled by variable-speed drives or

electronically-commutated motors. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:

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

2. The volume of outdoor air required to meet the ventilation requirements of the Seattle Mechanical Code.

***

1413.1 Operation: Air economizers shall be capable of automatically modulating outside and return air dampers to provide 100 percent of the design supply air as outside air to reduce or eliminate the need for mechanical cooling. The design supply air is the total airflow provided through the heating or cooling source. Systems shall provide a means to relieve excess outdoor air during air economizer operation to prevent overpressurizing the building. Air economizers shall be used for RS-29 analysis base case for all systems without exceptions in Sections 1413, 1423, or 1433. Water economizers, when allowed by Section 1132.2 exception 1 or Section 1433 exceptions 3 and 9, shall 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.

***

1413.3 Integrated Operation: The HVAC system and its controls shall allow economizer operation when mechanical cooling is required simultaneously. Air and water economizers shall

be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

((~~EXCEPTIONS:~~

~~1. Individual, direct expansion units that have a rated capacity less than 65,000 Btu/h and use nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling.~~

~~2. Water-cooled water chillers with waterside economizer.~~))

***

1413.5 Economizer Heating System Impact. Any HVAC system that increases the building heating energy use during economizer operation is not allowed (e.g. single-fan/dual-duct systems and multizone systems).

EXCEPTION: Where the heating is allowed by Section 1435.

Informative Note: Single-fan/dual-duct systems and multizone systems do not comply with this requirement. This is because economizer operation lowers the temperature of the air entering the hot deck heating coil, increasing its energy use. In order to use this type of system, the system must meet one of the economizer exceptions and have neither type of economizer. (Another resolution is to use a dual-fan/dual-duct system where the hot deck fan supplies only return air or return air plus minimum ventilation air.)

This requirement will not affect three-deck multizone since they cannot work with an air economizer in any case (it would make the neutral deck a cold deck).

An exception to this Section 1413.5 is provided for economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature. Reducing supply air

temperatures on a cooling-VAV system will reduce fan energy (particularly if the system has a variable speed drive), offsetting the energy lost due to increased reheat energy.

See the discussion and diagrams in the ASHRAE Standard 90.1-2007 User's Manual, Section 6.5.1.4, page 6-52.

***

1414.1 Duct Sealing and Testing: Duct work and plenums shall be sealed in accordance with Section 1414.1.1. Additionally, ducts shall be tested in accordance with Sections 1414.1.2 and 1414.1.3 as required.

1414.1.1 Sealing: Duct work which is designed to operate at pressures above 1/2 inch water column static pressure shall be sealed as follows:

1. Static pressure 1/2 inch to 3 inches: Seal all transverse joints and longitudinal seams. Spiral lock seams in round and flat oval duct work do not require sealing; however, other seams shall be sealed.
2. Static pressure above 3 inches: Seal all transverse joints, longitudinal seams and duct wall penetrations.

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, duct connections to equipment.

All low pressure supply and return air systems not located entirely within the conditioned space, including the unconditioned side of enclosed stud bays or joist cavities/spaces used to transport

air, shall be securely fastened and sealed. Duct work shall be sealed using welds, gaskets, mastic, or mastic-plus-embedded-fabric tape. Enclosed stud bays or joist cavities/spaces used to transport air shall be sealed using mastic-plus-embedded-fabric tape, or when drywall is used to enclose the air system, drywall mud and tape. Duct tape is not permitted as a sealant on any ducts.

EXCEPTION: Fibrous glass duct systems installed in accordance with Standard UL 181A and flexible duct systems installed in accordance with Standard UL 181B may use tapes listed for these systems.

1414.1.2 Low Pressure Duct Leak Test: All duct systems shall be sealed to a leakage rate not to exceed 6 percent of the fan flow if the duct system:

1. Is connected to a constant volume, single zone, air conditioner, heat pump or furnace; and
2. Serves less than 5,000 square feet of floor area; and
3. Has more than 25 percent duct surface area located in any unconditioned space.

The leakage rate shall be confirmed through field verification and diagnostic testing, in accordance with SMACNA Duct Leakage Test Procedures - 1985.

1414.1.3 High Pressure Duct Leak Test: Duct work that is designed to operate at static pressures in excess of 3 inches water column and all ductwork located outside the building envelope shall be leak-tested in accordance with SMACNA Duct Leakage Test Procedures - 1985. Representative sections totaling no less than ((~~25~~)) 75 percent of the total installed duct area for the designated pressure class and all ductwork located outside the building envelope shall be tested. Duct systems with pressure ratings in excess of 3 in. w.c. shall be identified on the drawings. The maximum permitted duct leakage shall be:

$$L_{max} = C_L P^{0.65}$$

Where:

L_{max} = Maximum permitted leakage in cfm/100 ft^2 duct surface area.

C_L = Duct leakage class, cfm/100 ft^2 at 1 in. w.c.

C_L = 6 for rectangular sheet metal, rectangular fibrous, and round flexible ducts.

C_L = 3 for round/flat oval sheet metal or fibrous glass ducts.

P = Test pressure, which shall be equal to the design duct pressure class rating in in. w.c.

1414.2 Insulation: Ducts and plenums that are constructed and function as part of the building envelope, by separating interior space from exterior space, shall meet all applicable requirements of Chapter 13. These requirements include insulation installation, moisture control, air leakage, and building envelope insulation levels. ((~~Unheated equipment rooms with combustion air louvers shall be isolated from the conditioned space by insulating interior surfaces to a minimum of R-11 and any exterior envelope surfaces per Chapter 13~~)). Outside air ducts serving individual supply air units with less than 2,800 cfm of total supply air capacity shall be insulated to a minimum of R-7 and are not considered building envelope. Other outside air duct runs are considered building envelope until they,

1. connect to the heating or cooling equipment, or
2. are isolated from the exterior with an automatic shut-off damper complying with Section 1412.4.1.

Once outside air ducts meet the above listed requirements, any runs within conditioned space shall comply with Table 14-5 requirements.

Other ducts and plenums shall be thermally insulated per Table 14-5.

EXCEPTIONS:

1. Within the HVAC equipment.

2. Exhaust air ducts not subject to condensation.

3. Exposed ductwork within a zone that serves that zone.

1415 Piping Systems

1415.1 Insulation: Piping shall be thermally insulated in accordance with Table 14-6.

EXCEPTION: Piping installed within unitary HVAC equipment.

Cold water pipes outside the conditioned space shall be insulated in accordance with the Washington State Plumbing Code (WAC 51-56).

1415.2 Radiant Systems.

1415.2.1 Sensible Heating and Sensible Cooling Panel Insulation. All thermally ineffective panel surfaces of sensible heating panels and sensible cooling panels, including U-bends and headers, shall be insulated with a minimum of R-3.5. Adjacent envelope insulation counts toward this requirement.

1415.2.2 Radiant Floor Heating and Radiant Ceiling Cooling. The bottom surfaces of floor structures incorporating radiant heating and the top surfaces of ceiling structures incorporating radiant cooling shall be insulated with a minimum of R-3.5. Adjacent envelope insulation counts toward this requirement.

EXCEPTION: Requirements for heated slab-on-grade floors incorporating radiant heating are in Chapter 13.

1416 Commissioning and Completion Requirements.

1416.1 General. Drawing notes or specifications shall require commissioning and completion requirements in accordance with this section.

1416.2 Commissioning Scope. Commissioning in compliance with this section and Section 1513.((~~7~~))8 shall be required for new systems or modified portions of systems((~~, with a heating capacity of 600K Btu/h or a cooling capacity of 40 tons or more~~)).

1416.2.1 Buildings which require commissioning shall go through a commissioning process that includes as a minimum:

1. Commissioning plan;
2. Systems testing and balancing;
3. HVAC equipment and HVAC controls functional testing;
4. Supporting documentation in the form of operation and maintenance and record documents;
5. Commissioning report.

1416.3 Commissioning Requirements.

1416.3.1 Commissioning Plan. Commissioning plan shall include:

1. A general description of the commissioning process activities including the systems to be commissioned;
2. The scope of the commissioning process including systems testing and balancing, functional testing, and supporting documentation;
3. Roles and responsibilities of the commissioning team;
4. A schedule of activities including systems testing and balancing, functional testing, and supporting documentation;
5. Functional test procedures and forms.

1416.3.2 Systems Testing and Balancing.

1416.3.2.1 General. All HVAC air and hydronic systems shall be balanced in accordance with generally accepted engineering standards.

1416.3.2.2 Air Systems Balancing. Throttling losses shall be minimized by balancing the systems or adjusting the speed of fans with motors greater than 1 hp.

1416.3.2.3 Hydronic Systems Balancing. Throttling losses shall be minimized by balancing the systems, or trimming the pump impeller or adjusting the pump speed.

EXCEPTIONS: 1. Pumps with pump motors of 10 hp or less.

2. Throttling is an acceptable method of balancing only if the power draw does not exceed that of equivalent system with the impeller trimmed by more than 5 percent.

All hydronic heating or cooling coils with design flow exceeding 20 gpm (76 L/m) shall be equipped with dedicated pressure testing ports to enable testing of pressure drop through the coil. All hydronic heating or cooling systems served by pump(s) exceeding 5 hp (3.7 kW) shall be equipped with accessible pressure testing ports to enable testing supply and return pressure near the end of each major hydronic run.

1416.3.3 Systems, Equipment, and Controls Functional Testing. All HVAC systems, equipment, and controls as well as metering as specified in Chapter 12 and lighting controls as specified in Section 1513.((7))8 shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with sequences of operation prescribed in the construction documents. Written procedures which clearly describe the individual systematic test procedures, the expected systems' response or acceptance criteria for each procedure, the actual response or findings, and any pertinent discussion. Optional examples of test methods and forms are provided in Reference Standard 34.

1416.3.4 Supporting Documentation. Supporting documentation shall include, as a minimum:

1416.3.4.1 Systems Documentation. Systems documentation shall be in accordance with industry accepted standards and shall include as a minimum:

1. Submittal data stating equipment size and selected options for each piece of equipment.
2. Operation and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of at least one HVAC service agency.
4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, as-built drawings and control sequence descriptions. Desired or field determined set points shall be permanently recorded on control drawings at control devices, or, for digital control systems, in programming comments.
5. Complete written narrative of how each system and piece of equipment is intended to operate including interface with existing equipment or systems (where applicable). Sequence of operation is not acceptable as a narrative for this requirement.

1416.3.4.2 Record Documents. Construction documents shall be updated to convey a record of the alterations to the original design. Such updates shall include updated mechanical, electrical and control drawings red-lined, or redrawn if specified, that show all changes to size, type and location of components, equipment and assemblies.

1416.3.4.3 Systems Operation Training. Training of the maintenance staff for each equipment type and or system shall include as a minimum:

1. Review of systems documentation.
2. Hands-on demonstration of all normal maintenance procedures, normal operating modes, and all emergency shutdown and start-up procedures.

3. Training completion report.

1416.3.5 Commissioning Report. The commissioning report shall be completed and provided to the owner. The commissioning report shall include:

1. Completed Functional Test forms including measurable criteria for test acceptance.
2. Issues log of corrected and uncorrected deficiencies with the anticipated date of correction.
3. Deferred tests, which cannot be performed at the time of report preparation, with anticipated date of completion.
4. Record of progress and completion of operator training.
5. Completed Commissioning Compliance form.

1416.4 Commissioning Compliance Form. A commissioning compliance checklist shall be submitted to the building official upon substantial completion of the work included in each permit((~~building~~)). The checklist shall be completed and signed by the building owner or owner's representative. The building official may require that the Commissioning Compliance form components be submitted to verify compliance with Sections 1416 and 1513.8 requirements. Completion of the Commissioning Compliance Checklist (Figure 14B) is deemed to satisfy this requirement.

FIGURE 14B

COMMISSIONING COMPLIANCE CHECKLIST

Project	**Project Name:**
	Project Address:

Information	Commissioning Authority:
Commissioning Plan (Section 1416.3.1)	❑ **Commissioning Plan was used during construction and included items below** • A written schedule including Systems Testing and Balancing, Functional Testing, and Supporting Documentation. • Roles and Responsibilities of the commissioning team. • Functional Test procedures and forms.
Systems Balancing (Section 1416.3.2)	❑ **Systems Balancing has been completed** • Air and Hydronic systems are proportionately balanced in a manner to first minimize throttling losses. • Test ports are provided on each pump for measuring pressure across the pump.
Functional Testing (Section 1416.3.3)	❑ **HVAC Systems Functional Testing has been completed** (Section 1416.3.3) HVAC systems have been tested to ensure that equipment, components, and subsystems are installed, calibrated, adjusted and operate in accordance with approved plans and specifications. ❑ **HVAC Controls Functional Testing has been completed** (Section 1416.3.3) HVAC controls have been tested to ensure that control devices are calibrated, adjusted and operate properly. Sequences of operation have been functionally tested to ensure they operate in accordance with approved plans and specifications.

	❑ **Lighting Controls Functional Testing has been completed** (Section 1513.((~~7~~))8) Lighting controls have been tested to ensure that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications.
Supporting Documents (Section 1416.3.4)	❑ **Systems documentation, record documents and training have been completed or are scheduled.** • System documentation has been provided to the owner or scheduled date:_____ • Record documents have been submitted to owner or scheduled date:_____ • Training has been completed or scheduled date:_____
Commissioning Report (Section 1416.3.5)	❑ **Commissioning Report submitted to Owner and includes items below.** • Completed Functional Tests documentation. • Deficiencies found during testing required by this section which have not been corrected at the time of report preparation and the anticipated date of correction. • Deferred tests, which cannot be performed at the time of report preparation due to climatic conditions or other circumstances beyond control of Commissioning Authority.

Certification	☐	I hereby certify that all requirements for commissioning have been completed in accordance with the ((~~Washington State~~))Seattle Energy Code, including all items above. _____ Building Owner or Owner's Representative Date

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1431.2 System Sizing Limits: Heating and cooling design loads for the purpose of sizing systems shall be determined in accordance with one of the procedures described in Chapter 29 of Standard RS-1 listed in Chapter 7 or an equivalent computation procedure. For interior temperatures, 70°F shall be used for heating and 75°F for cooling, except where different values are specified in the Washington Administrative Code (WAC). For exterior temperatures, 24°F shall be used for heating and 82°F dry bulb and 66°F for wet bulb for cooling.

Building mechanical systems for all buildings which provide space heating and/or space cooling shall be sized no greater than 150 percent of the design load as calculated above, except that cooling towers shall comply with the sizing requirements in Section 1411.1. No additional safety factor is allowed.

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.

EXCEPTION: The following limited exemptions from the sizing limit shall be allowed; however, in all cases heating and/or cooling design load calculations shall be submitted.

1. For a single piece of equipment which has both heating and cooling capability, only one function, either the heating or the cooling, need meet the requirements of this section. Capacity for the other function shall be, within available equipment options, the smallest size necessary to meet the load.

2. Stand-by equipment may be installed if controls and devices are provided which allow redundant equipment to operate automatically only when the primary equipment is not operating.

3. Multiple units of the same equipment type, such as multiple chillers and boilers, with combined capacities exceeding the design load, or a single unit that is capable of modulating to a part-load capacity of 50 percent of the load or less, may be specified to operate concurrently only if controls are provided that sequence or otherwise optimally control the operation of each unit based on load.

4. Installed space heating equipment output that does not exceed 10 Btu/h per square foot of gross conditioned floor area and installed space cooling equipment output that does not exceed 15 Btu/h per square foot of gross conditioned floor area. No additional safety factor is allowed.

1431.3 Hydronic System Design: All chilled water and condenser water piping shall be designed such that the design flow rate in each pipe segment shall not exceed the values listed in Table 14-3 for the appropriate total annual hours of operation. Pipe size selections for systems that operate under variable flow conditions (e.g. modulating 2-way control valves at coils) and that contain variable speed pump motors are allowed to be made from the "Variable Flow/Variable Speed" columns. All others shall be made from the "Other" columns. (Note: The flow rates listed here do not consider noise or erosion. Lower flow rates are often recommended for noise sensitive locations.)

EXCEPTION: Design flow rates exceeding the values in Table 14-3 are allowed in specific sections of pipe if the pipe in question is not in the critical circuit at design conditions and is not predicted to be in the critical circuit during more than 30% of operating hours.

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1432.2 Systems Temperature Reset Controls

1432.2.1 Air Systems for Multiple Zones: Systems supplying heated or cooled air to multiple zones shall include controls which automatically reset supply air temperatures by representative building loads. Temperature shall be reset by at least 25 percent of the design supply-air-to-room-air temperature difference. Interior zones without an exterior wall load impact and high occupancy areas (per Section 1412.8) shall have maximum airflow sized to meet typical cooling loads with the higher reset air temperature.

EXCEPTIONS:

1. Where specified humidity levels are required to satisfy process needs, such as computer rooms or museums.
2. Systems that prevent reheating, recooling, or mixing of heated and cooled air supply.
3. 75 percent of the energy for reheating is from site-recovered or site solar energy sources.
4. Zones with peak supply air quantities of 300 cfm or less.
5. Dedicated outdoor air systems less than 5,000 cfm with separate thermal controls.

1432.2.2 Hydronic Systems: Systems with a design capacity of 300,000 Btu/h or greater supplying heated or mechanically refrigerated water shall include controls which automatically reset supply water temperatures by representative building loads or by outside air temperature. Temperature shall be reset by at least 25 percent of the design supply-to-return water temperature differences.

EXCEPTIONS:

1. Steam boilers.

2. Systems that provide heating with 100°F or lower supply temperature (e.g., water source heat pump loops).

To limit the heat loss from the heat rejection device (cooling tower), for hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g., cooling tower):

a. If a closed-circuit tower (fluid cooler) is used, either an automatic valve shall be installed to bypass all but a minimal flow of water around the tower (for freeze protection), or low leakage positive closure dampers shall be provided.

b. If an open-circuit tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the tower.

c. If an open-circuit tower is used in conjunction with a separate heat exchanger to isolate the tower from the heat pump loop, then heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

For hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g., cooling tower) and having a total pump system power 5 hp and greater ((~~exceeding 10 hp~~)), each hydronic heat pump shall have:

a. A two-position two-way (but not three-way) valve, or

b. A variable head pressure two-way (water regulating) control valve or pump.

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 1438.

***

1433 Economizers. Air economizers meeting the requirements of Section 1413 shall be provided on all ((~~new~~)) systems including those serving computer server rooms, electronic equipment, radio equipment, telephone switchgear, medical and laboratory equipment, and also on redundant equipment.

EXCEPTIONS:

1. a. Qualifying small equipment: This exception shall not be used for unitary cooling equipment installed outdoors or in a mechanical room adjacent to the outdoors. This exception is allowed to be used for other cooling units and split systems with a total cooling capacity rated in accordance with Section 1411.2 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% higher than minimum efficiencies listed in Tables 14-1A, 14-1B and 14-1D, 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% of its air economizer capacity, whichever is greater. That portion of the equipment serving Group R Occupancy is not included in determining the total capacity of all units without economizers in a building. Redundant units are not included in determining the total capacity of all units without economizers in a building ((~~counted in the capacity limitations~~)). This exception shall not be used for the shell-and-core permit or for the initial tenant improvement (i.e. the first time that the space is occupied) or for RS-29 analysis.

   b. Qualifying very-small very-high efficiency equipment: This exception shall not be used for unitary cooling equipment installed outdoors or in a mechanical room adjacent to the outdoors. This exception is allowed to

be used for other cooling units and split systems with a total cooling capacity rated in accordance with Section 1411.2 of less than or equal to 24,000 Btu/h (hereafter referred to as "qualifying very-small very-high efficiency equipment") provided that these are high-efficiency cooling equipment with SEER and EER values more than 64% higher than minimum efficiencies listed in Tables 14-1A, 14-1B and 14-1D, in the appropriate size category, using the same test procedures. If a unit is rated with an IPLV, IEER or SEER, then to eliminate the required economizer, the minimum cooling efficiency of the HVAC unit shall 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 shall be increased by the percentage shown. Equipment shall be listed in the appropriate certification program to qualify for this exception. The total capacity of all qualifying very-small very-high efficiency equipment without economizers shall not exceed 24,000 Btu/h per tenant space. This exception shall not be used for the shell-and-core permit or for the initial tenant improvement or for RS-29 analysis.

Informative Note: Exception 1 is only applicable to HVAC equipment that complies with Section 1411.1 and is regulated in Tables 14-1A, 14-1B and 14-1D.

Section 1411.1 requires that "if a nationally recognized certification program exists for a product covered in Tables 14-1A through 14-1G, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program." As of the date of adoption of this Code, the AHRI program does satisfy those criteria. Therefore, products subject to the AHRI standards must be listed in the AHRI certification program.

In Tables 14-1A, 14-1B, and 14-1D, virtually all of the equipment efficiency ratings are required to be determined in accordance with an AHRI Standard (though some products are rated in accordance with ASHRAE Standard 127). Energy Code compliance is determined at standard conditions (not at project specific conditions). Compliance should be verifiable through the

AHRI directory at www.ahridirectory.org. It is not acceptable for a manufacturer to submit its own calculations for AHRI standards.

Consequently, to use exception 1 to Section 1433, a product must both: be within the scope of the specified AHRI standard and be included in the AHRI certification program (except for those products rated in accordance with ASHRAE Standard 127). Certain equipment used in computer server rooms is not within the scope of the standards listed in Tables 14-1A, 14-1B, and 14-1D and is not eligible for certification. Therefore, such equipment does not qualify to use exception 1 to Section 1433 (though it may qualify to use another exception).

Informative Note: The exceptions to Section 1433 generally are not equal-energy alternates to a system with air economizer. For example, the 15% higher efficiency cooling units allowed in Exception 1a do not come close to providing equivalence to air economizer.

However, in response to requests, ASHRAE has calculated the improvement in cooling equipment efficiency necessary to compensate for the lack of outside air cooling capability of an economizer. For western Washington, the cooling equipment efficiency improvement required is 64%. This is the basis for the criteria in Exception 1b. At the time this Code was adopted, it was not known whether there were equipment models on the market that could be shown to meet the criteria in Exception 1b.

2. Chilled water terminal units connected to systems with chilled water generation equipment with IPLV values more than 25% higher than minimum part load efficiencies listed in Table 14-1C, in the appropriate size category, using the same test procedures. Equipment shall be listed in the appropriate certification program to qualify for this exception. The total capacity of all systems without economizers shall not exceed ((~~480,000~~)) 72,000 Btu/h per building, or ((~~20~~)) 5% of its air economizer capacity, whichever is greater. That portion of the equipment serving Group R Occupancy is not included in determining the total capacity of all units without economizers in a

building. This exception shall not be used for the shell-and-core permit or for the initial tenant improvement or for RS-29 analysis.

3. Water-cooled refrigeration equipment ((~~serving chilled beams and chilled ceilings space cooling systems only~~)) which are provided with a water economizer meeting the requirements of Section 1413 and that serve only the following space cooling systems:

   a. chilled floor slabs not covered with other material and having direct exposure to the space,

   b. chilled beams,

   c. chilled ceilings.

   Water economizer capacity per building shall not exceed 500 tons. This exception shall not be used for RS-29 analysis.

Informative Note: This water economizer exception applies to equipment that only serves chilled floor slabs, chilled beams, and chilled ceilings space cooling systems. Chilled floor slabs, chilled beams, and chilled ceilings space cooling systems are often partnered with Direct Outside Air Supply (DOAS) systems. The DOAS system is not included in this exception and must comply with the air economizer requirements, unless it qualifies for one of the other exceptions.

4. Systems for which at least 75% of the annual energy used for mechanical cooling is provided from site-recovery or site-solar energy source.

5. Systems where special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes an air economizer infeasible.

6. Systems with dehumidification that affect other systems so as to increase the overall building energy consumption. New humidification equipment shall comply with Section 1413.4.

7. Systems complying with all of the following criteria:

   a. Consist of multiple water source heat pumps with a total cooling capacity for each water-source heat pump of less than 54,000 Btu/h that are connected to a common water loop;

   b. Have a minimum of 60% air economizer complying with Section 1413 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;

   c. Have water source heat pumps with an EER at least 15% higher for cooling and, for units serving perimeter zones with heating loads (e.g. zones with exterior walls, roofs, or floors), a COP at least 15% higher for heating than that specified in Section 1411;

   d. Where provided with a dedicated boiler or furnace for that building, have a central boiler or furnace efficiency of 90 percent minimum; and

   e. Provide heat recovery with a minimum 50% heat recovery effectiveness as defined in Section 1436 to preheat the outside air supply.

8. For Group R Occupancy, cooling units installed outdoors or in a mechanical room adjacent to outdoors with a total cooling capacity less than 20,000 Btu/h and other cooling units with a total cooling capacity less than 54,000 Btu/h provided that these are high-efficiency cooling equipment with SEER and EER values more than 15 percent higher than minimum efficiencies listed in Tables 14-1A, 14-1B and 14-1D, 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.

Informative Note: Chillers with fan coil units do not qualify for this exception as chillers are not covered in Tables 14-1A, 14-1B, or 14-1D. Most variable refrigerant flow (VRF) systems are too

large and also do not qualify for this exception, as AHRI 1230, the standard for rating the efficiency of VRF systems in Tables 14-1A(3)-(4), bases the capacity on the outside unit size.

9. Equipment used to cool any dedicated server room, electronic equipment room or telecom switch room provided that they completely comply with option 9a, 9b, ((~~or~~)) 9c, 9d, or 9e in the table below. The total capacity of all qualifying systems without economizers shall not exceed 240,000 Btu/h per building or 10 percent of its air economizer capacity, whichever is greater. This exception shall not be used for RS-29 analysis.

10. Variable refrigerant flow (VRF) systems, multiple-zone split-system heat pumps, consisting of multiple, individually metered indoor units with multi-speed fan motors, served on a single common refrigeration circuit with an exterior reverse-cycle heat pump with variable speed compressor(s) and variable speed condenser fan(s). These systems shall also be capable of providing simultaneous heating and cooling operation, where in all zones with VRF units recovered energy from the indoor units operating in one mode can be transferred to one or more indoor units operating in the other mode, and shall serve at least 20 percent internal (no perimeter wall within 12 feet ((.))) and 20 percent perimeter zones (as determined by conditioned floor area) and the outdoor unit shall be at least 65,000 Btu/h in total capacity. Systems utilizing this exception shall have 50 percent heat recovery effectiveness on the outside air. For the purposes of this exception, dedicated server rooms, electronic equipment rooms or telecom switch rooms are not considered perimeter zones and shall not exceed 20% of the floor area served by the VRF system. This exception shall be limited to buildings of 60,000 square feet and less.

Procedural Requirement: The materials submitted with the permit application shall specify the gross conditioned floor area of the building.

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

	Equipment Type	Higher Equipment Efficiency	Part-Load Control	Economizer
Option 9a	Table 14-1A and Table 14-1B[a]	+ 15%[b]	Required over 85,000 Btu/h[c]	None required
Option 9b	Table 14-1A and Table 14-1B[a]	+ 5%[d]	Required over 85,000 Btu/h[c]	Dedicated Waterside economizer
Option 9c	ASHRAE Standard 127[f]	+ ((θ)) 10%[g]	Required over 85,000 Btu/h[c]	Dedicated Waterside economizer
Option 9d	Table 14-1C[h]	+ 25%[i]	Required for all chillers[j]	None required
Option 9e	Table 14-1C[h]	+ 10/15%[k]	Required over 85,000 Btu/h[c]	Dedicated Waterside economizer

Footnotes to table

a. For a system where all of the cooling equipment is subject to the AHRI standards listed in Tables 14-1A and 14-1B, the system shall comply with all of the following (note that if the system contains any cooling equipment that exceeds the capacity limits in Table 14-1A or 14-1B, or if the system contains any cooling equipment that is not included in Table 14-1A or 14-1B, then the system is not allowed to use this option).

b. The cooling equipment shall have an SEER/EER value and an IEER/IPLV value that each is a minimum of 15 percent greater than the value listed in Tables 14-1A and 14-1B (1.15 x values in Tables 14-1A and 14-1B).

c. For units with a total cooling capacity over 85,000 Btu/h, the system shall utilize part-load capacity control schemes that are able to modulate to a part-load capacity of 50 percent of the load or less that results in the compressor operating at the same or higher EER at part loads than at full load (e.g., minimum of two-stages of compressor unloading such as cylinder unloading, two-stage scrolls, dual tandem scrolls, but hot gas bypass is not credited as a compressor unloading system).

d. The cooling equipment shall have an SEER/EER value and an IEER/IPLV value that each is a minimum of 5 percent greater than the value listed in Tables 14-1A and 14-1B (1.05 x values in Tables 14-1A and 14-1B).

e. The system shall include a water economizer in lieu of air economizer. Water economizers shall 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 127-2007.

g. The cooling equipment subject to the ASHRAE Standard 127-2007 shall have ((~~an EER value and an IPLV~~)) a SCOP value that is ((~~equal or~~)) a minimum of 10 percent greater than the value listed in Tables 14-1A(2) (1.10 x values in Tables 14-1A(2)) ((~~and 14-1B~~)) when determined in accordance with the rating conditions in ASHRAE Standard 127-2007 (i.e., not the rating conditions in AHRI Standard 210/240 or 340/360). ((~~This~~)) Effective January 1, 2012, this information shall be provided by an independent third party.

h. For a system with chillers subject to the AHRI standards listed in Table 14-1C (e.g. a chilled water system with fan coil units).

i. The cooling equipment shall have an full-load EER value and an IPLV value that is a minimum of 25 percent greater than the value listed in Table 14-1C (1.25 x value in Table 14-1C), or a full-load and IPLV kW/ton that is at least 25 percent lower than the value listed in Table 14-1C (0.75 x value in Table 14-1C).

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, 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% greater than the IPLV EER value listed in Table 14-1C (1.10 x values in Table 14-1C). For water-cooled chillers, the cooling equipment shall have an IPLV kW/ton that is at least 15% lower than the IPLV kW/ton value listed in Table 14-1C (0.85 x values in Table 14-1C).

Informative Note: Options 9a and 9b are only applicable to HVAC equipment that complies with Section 1411.1 and is regulated in Tables 14-1A and 14-1B.

Section 1411.1 requires that "if a nationally recognized certification program exists for a product covered in Tables 14-1A through 14-1G, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program." As of the date of adoption of this Code, the AHRI program does satisfy those criteria. Therefore, products subject to the AHRI standards must be listed in the AHRI certification program.

In Tables 14-1A and 14-1B, virtually all of the equipment efficiency ratings are required to be determined in accordance with an AHRI Standard (though some products are rated in accordance with ASHRAE Standard 127). As specified in Section 1411.2, Energy Code compliance is determined at standard conditions (not at project specific conditions). Compliance should be verifiable through the AHRI directory at www.ahridirectory.org. It is not acceptable for a manufacturer to submit its own calculations for AHRI standards.

Equipment used in computer server rooms that is within the scope of ASHRAE Standard 127, Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners is also eligible to use exception 9 option 9c to Section 1433.

Informative Note: For hydronic systems over 300,000 Btuh, see Section 1432.2.2.

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1435 Simultaneous heating and cooling. Systems which provide heating and cooling simultaneously to a zone are prohibited. Zone thermostatic and humidistatic controls shall be capable of operating in sequence the supply of heating and cooling energy to the zone. Such controls shall prevent:

a. Reheating for temperature control.

b. Recooling for temperature control.

c. Mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by economizer systems, ((~~ground water~~)) ground-coupled hydronic loops, or by mechanical refrigeration.

d. Other simultaneous operation of heating and cooling systems to the same zone.

e. Reheating for humidity control.

EXCEPTIONS:

1. Variable air volume (VAV) systems which, during periods of occupancy are designed and controlled:

1.1 To reduce the primary air supply to each zone to a minimum air volume when the zone temperature is in a 5°F (3°C) zone temperature dead band after cooling is no longer required and before reheating, recooling or mixing takes place. This minimum volume shall be no greater than the larger of the following:

1.1.1 Twenty percent of the peak supply volume; or

1.1.2 The volume of outdoor air required to meet zone ventilation requirements, unless increasing the volume to critical zones (zones with the highest ratio of outside air to total supply air) beyond the minimum ventilation requirements results in a decrease in overall outside air required by the HVAC system. An increase beyond minimum ventilation rates shall not be applied to more than 20 percent of the zones with reheat on any one system excluding zones equipped with ventilation controls for high occupancy areas required by Section 1317.2.2.

1.2 So the volume of air that is reheated, recooled, or mixed in peak heating demand shall be less than 50 percent of the zone design peak supply rate.

1.3 So the airflow between dead band and full heating or full cooling shall be modulated.

1.4 So the control logic of each system shall have means preventing changes in setpoint(s) from inducting simultaneous heating and cooling (including economizer cooling) except for humidity control or zone controls operating as described under exception 1.1.

2. Zones where special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates are such that variable air volume systems are impractical, such as some areas of hospitals and laboratories. Systems which use this exception and supply heated or cooled air to multiple zones shall include:

2.1 Controls that automatically reset supply air temperatures by representative building loads or by outside air temperature unless it can be shown that supply air temperature reset increases overall building annual energy costs. In all cases, these controls shall comply with the requirements in Section 1432.2.

2.2 Variable speed drives for supply, ((~~and~~)) return, and exhaust fans, modulating pressure independent zone dampers on all zones (supply, return, and exhaust fans where applicable), specified occupied and unoccupied or low occupancy airflows, and have controls which reduce airflow in response to changes in occupancy levels.

3. Zones where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered (including condenser heat) or site solar energy source.

4. Zones where specific humidity levels are required to satisfy process needs, such as ((~~computer rooms,~~)) museums, surgical suites, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas. This exception does not apply to computer rooms.

5. Zones with a peak supply air quantity of 300 cfm (142 L/s) or less.

6. Three deck multizone systems that mix economizer-cooled (mixed) air with heated or cooled air where the temperature of the economizer-cooled air is reset based on weighted zone heating and cooling loads and zone airflow is reduced to a minimum of 20% design airflow or the volume of outdoor air required to meet zone ventilation requirements before mixing is allowed.

1436 ((~~Heat~~)) Energy Recovery.

Informative Note: As indicated in Section 1120, the Energy Code applies to industrial facilities, as well as commercial and industrial processes. Thus, the energy recovery requirements apply to industrial facilities, as well as systems and equipment used in commercial and industrial processes.

1436.1 Fan Systems: Fan systems which have a minimum outdoor air capacity of 5,000 cfm or greater shall have an ((~~heat~~)) energy recovery system that is designed for, and operates during, both the heating and the cooling seasons, with at least 50 percent heat recovery effectiveness. For the purposes of sizing the energy recovery system, the applicant shall submit calculations demonstrating that the system will provide at least 50% heat recovery effectiveness. Fifty percent heat recovery effectiveness shall mean an increase in the outside air supply temperature at design heating conditions of one half the difference between the outdoor design air

temperature and 65°F. Provision shall be made to bypass or control the ((~~heat~~)) energy recovery system to permit air economizer operation as required by Section 1433. ((~~Heat~~)) Energy recovery energy may be provided from any site-recovered or site-solar source. 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.

Informative Note: In Seattle, the outdoor design air temperature is 24°F as specified in Table 3-1. The difference between 24°F and 65°F is 41 degrees. One-half of 41 degrees is 20.5 degrees. Therefore, to provide 50% heat recovery effectiveness in Seattle, the heat recovery system shall raise the outside supply air temperature to a minimum of 44.5°F (24°F + 20.5°F) at the outdoor design conditions.

EXCEPTIONS: These exceptions only apply to the particular exhaust subsystems. The remaining cfm of the main supply system is subject to the energy recovery requirements.

1. ((~~Laboratory systems equipped with both variable air volume supply and variable air volume or two speed exhaust fume hoods provided that an instruction label is placed on the face of the hood that provides the information in Exhibit 14-1.~~)) Reserved.

((~~Exhibit 14-1~~

~~INSTRUCTIONS TO OPERATOR~~

~~To be in compliance with the Energy Code, this fume hood is designed to operate as variable air volume (VAV) by adjusting the sash or controller. Maintain sash in the minimum position during use and close totally when the fume hood is not in use.~~

))

2. Systems serving spaces heated to less than 60 degrees F.

3. Systems which can be shown to use as much energy with the addition of heat recovery equipment as without it.

4. Systems exhausting toxic, flammable, paint exhaust or corrosive fumes making the installation of heat recovery equipment impractical.

5. Type I commercial kitchen hoods.

6. Systems that only provide cooling.

7. Cooling only air handling units or air conditioning units where the minimum outdoor air is less than 70 percent of total supply air.

Laboratory systems shall also comply with Section 1439.2.

1436.2 Condensate Systems: ((~~On-site steam h~~))Heating systems with on-site steam generation shall have condensate water recovery. On-site includes a system that is located within or adjacent to one or more buildings within the boundary of a contiguous area or campus under one ownership and which serves one or more of those buildings.

Buildings using steam generated off-site with steam heating systems which do not have condensate water recovery shall have condensate water recovery.

1436.3 Heat Recovery for Service Water Heating: Condenser water heat recovery systems shall be installed for heating or preheating of service hot water provided all of the following are true:

a. The facility operates 24 hours a day.

b. The total installed heat rejection capacity of the water-cooled systems exceeds 1,500,000 Btu/h of heat rejection.

c. The capacity of service water heating equipment exceeds 250,000 Btu/h.

The required heat recovery system shall have the capacity to provide the smaller of:

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

b. Preheat of the peak service hot water draw to 85°F; or

c. 50 percent of the service water heating load.

EXCEPTIONS:

1. Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.

2. Facilities that provide 60 percent of their service water heating from site solar or site recovered energy or from other sources.

Informative Note: This requirement typically applies to hotels, dormitories, mixed-use retail/residential projects, commercial kitchens, and institutions such as prisons and hospitals according to the ASHRAE/IESNA Standard 90.1 User's Manual, page 6-76.

1436.4 Condenser Heat Recovery: Facilities having food service, meat or deli departments and having 500,000 Btu/h or greater of remote refrigeration condensers shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, space heating or for dehumidification reheat. Facilities having a gross conditioned floor area of 40,000 ft^2 or greater and 1,000,000 Btu/h or greater of remote refrigeration shall have condenser waste heat recovery from freezers and coolers and shall use the waste heat for service water heating, and either for space heating or for dehumidification reheat for maintaining low

space humidity. The required heat recovery system shall have the capacity to provide the smaller of:

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

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

1437 Electric motor efficiency. Design A & B squirrel-cage, T-frame induction permanently wired polyphase motors of 1 hp or more having synchronous speeds of 3,600, 1,800 and 1,200 rpm shall have a nominal full-load motor efficiency no less than the corresponding values for energy efficient motors provided in Table 14-4.

EXCEPTIONS:

1. Motors used in systems designed to use more than one speed of a multispeed motor.
2. Motors used as a component of the equipment meeting the minimum equipment efficiency requirements of Section 1411 and Tables 14-1A through 14-1G provided that the motor input is included when determining the equipment efficiency.
3. Motors that are an integral part of specialized process equipment.
4. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.

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

Informative Note: As indicated in Section 1120, the Energy Code applies to industrial facilities, as well as commercial and industrial processes. Thus, the motor efficiency requirements apply to industrial facilities, as well as systems and equipment used in commercial and industrial processes.

1438 System Criteria. For fans and pumps ((~~7.5~~)) 5 horsepower and greater including custom and packaged air handlers serving variable air volume fan systems, constant volume fans, parking garage ventilation fans, heating and cooling hydronic pumping systems, pool and service water pumping systems, domestic water pressure boosting systems, cooling tower fan, and other pumps or fans where variable flows are required, there shall be:

a. Variable speed drives, or

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

Informative Note: At the time this Code was adopted, very few technologies could be shown to meet the criteria in option b.

EXCEPTION: Variable speed devices are not required for motors that serve:

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

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

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

Informative Note: As indicated in Section 1120, the Energy Code applies to industrial facilities, as well as commercial and industrial processes. Thus, the variable speed drive requirement applies to industrial facilities, as well as systems and equipment used in commercial and industrial processes.

1438.1 Heat Rejection Equipment: The requirements of this section apply to heat rejection equipment used in comfort cooling systems such as air-cooled condensers, open cooling towers, closed-circuit cooling towers, and evaporative condensers.

EXCEPTION: Heat rejection devices included as an integral part of equipment listed in Tables 14-1A through 14-1D.

Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table 14-1G. These requirements apply to all propeller, axial fan and centrifugal fan cooling towers. Table 14-1G specifies requirements for air-cooled condensers that are within rating conditions specified within the table.

1438.1.1 Variable flow controls: Cooling tower fans ((~~7.5~~)) 5 hp and greater shall have control devices that vary flow by controlling leaving fluid temperature or condenser temperature/pressure of the heat rejection device.

1438.1.2 Limitation on centrifugal fan cooling towers: Open cooling towers with a combined rated capacity of 1,100 gpm and greater at 95°F condenser water return, 85°F condenser water supply and 75°F outdoor wet-bulb temperature shall meet the energy efficiency requirement for axial fan open circuit cooling towers.

EXCEPTION: Open circuit cooling towers that are ducted (inlet or discharge) ((~~or have external sound attenuation~~)) that require((s)) external static pressure capability or open circuit cooling towers that have external sound attenuation.

1438.2 Hot gas bypass limitation: Cooling equipment with direct expansion coils rated at greater than 95,000 Btu/h total cooling capacity shall have a minimum of 2 stages of cooling capacity or capacity modulation other than hot gas bypass that is capable of reducing input and output by at least 50%.

1438.3 Large volume fan systems: Single or multiple fan systems serving a zone or adjacent zones without separating walls with total air flow over 10,000 cfm (3,540 L/s) are required to reduce airflow based on space thermostat heating and cooling demand. A variable speed drive shall reduce airflow to a maximum 75% of peak airflow or minimum ventilation air requirement as required by Section 403 of the IMC, whichever is greater.

EXCEPTIONS:

1. Systems where the function of the supply air is for purposes other than temperature control, such as maintaining specific humidity levels or supplying an exhaust system.
2. Dedicated outdoor air supply unit(s) with heat recovery where airflow is equal to the minimum ventilation requirements and other fans cycle off unless heating or cooling is required.
3. An area served by multiple units where designated ventilation units have 50% or less of total area airflow and nonventilation unit fans cycle off when heating or cooling is not required.

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1439.2 Laboratory Exhaust Systems: Buildings with laboratory exhaust systems having a total exhaust rate greater than 5,000 cfm (2,360 L/s) shall include heat recovery systems to precondition((~~ed~~)) makeup air from laboratory exhaust. The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 25°F (13.9°C) in Climate Zone 1 and 35°F (19.4°C) in Climate Zone 2. A provision shall be made to

bypass or control the heat recovery system to permit air economizer operation as required by Section 1433.

EXCEPTIONS:

1. Variable air volume laboratory exhaust and room supply systems capable of reducing exhaust and make-up air volume to 50% or less of design values; or

2. Direct make-up (auxiliary) air supply equal to at least 75% of the exhaust rate, heated no warmer than 2°F (1.1°C) below room set point, cooled to no cooler than 3°F (1.7°C) above room set point, no humidification added, and no simultaneous heating and cooling used for dehumidification control; or

3. Combined Energy Reduction Method: VAV exhaust and room supply system capable of reducing exhaust and makeup air volumes and a heat recovery system to precondition makeup air from laboratory exhaust that when combined will produce the same energy reduction as achieved by a heat recovery system with a 50% sensible recovery effectiveness as required above. For calculation purposes, the heat recovery component can be assumed to include the maximum design supply airflow rate at design conditions. The combined energy reduction (QER) shall meet the following:

   $QER \geq QMIN$

   $QMIN = CFMS \cdot (TR-TO) \cdot 1.1 \cdot 0.6$

   $QER = CFMS \cdot (TR-TO) \cdot 1.1(A+B)/100$

   Where:

   QMIN = Energy recovery at 60% sensible effectiveness (Btu/h)

   QER = Combined energy reduction (Btu/h)

   CFMS = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute

TR = Space return air dry bulb at winter design conditions

TO = 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

Laboratory systems shall also comply with Section 1436.1.

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1444 Conservation of Water and Pumping Energy. Pumps for all domestic water systems shall comply with Section 1438.

In addition, domestic water pressure booster systems shall be designed such that:

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

b. No device(s) 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.

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

***

1452 Pool Water 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 50.0°F db, 44.2°F wb, outdoor air and 80.0°F entering water,

determined in accordance with AHRI Standard 1160, Performance Rating of Heat Pump Pool Heaters((~~ASHRAE Standard 146, Method of Testing for Rating Pool Heaters~~)). Other pool heating equipment shall comply with the applicable efficiencies in Tables 14-1A through 14-1G.

***

1470 Compressed Air and Vacuum Air.

EXCEPTIONS: If used for medical purposes, compressed air and vacuum air are exempt from this section.

1470.1 Air Compressors (50-150 PSI), General: Air compressors operating at 50-150 PSI shall comply with the following:

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

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

1470.2 Rotary Screw Air Compressors over 10 hp (50-150 PSI): Rotary screw air compressors over 10 hp operating at 50-150 PSI shall not rely on modulation control and shall have one of the following:

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

b. Variable speed drive controlled air compressor, or

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

Informative Note: As indicated in Section 1120, the Energy Code applies to industrial facilities, as well as commercial and industrial processes. Thus, the air compressor requirements apply to

industrial facilities, as well as systems and equipment used in commercial and industrial processes.

1475 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.

Informative Note: Energy Star requirements are posted on the Energy Star website at: http://www.energystar.gov/index.cfm?c=product_specs.pt_product_specs

TABLE 14-1A(1)

Unitary Air Conditioners and Condensing Units, Electrically Operated, Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Air conditioners, air-cooled	< 65,000 Btu/h[d]		Split System and Single Package	13.0 SEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h		Split System and Single Package	11.2 EER[c] 11.4 IEER[c]	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h		Split System and Single Package	11.0 EER[c] 11.2 IEER[c]	
	≥240,000 Btu/h and < 760,000 Btu/h		Split System and Single Package	10.0 EER[c] 10.1 IEER[c]	
	≥ 760,000 Btu/h		Split System and Single Package	9.7 EER[c] 9.8 IEER[c]	
Through-the-wall, air-cooled	< 30,000 Btu/h[d]		Split System and Single Package	12.0 SEER	AHRI 210/240
Small-duct, high-velocity, air-cooled	< 65,000 Btu/h[d]		Split System	10.0 SEER	AHRI 210/240
Air conditioners,	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
water ((~~and evaporatively~~)) cooled	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER (before 6/1/2011) 12.1 EER (as of 6/1/2011) 11.7 IEER (before 6/1/2011) 12.3 IEER (as of 6/1/2011)	AHRI 340/360
		All other	Split System and Single Package	11.3 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.5 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.5 EER (as of 6/1/2011) 11.2 IEER (before 6/1/2011) 12.7 IERR (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.3 EER (as of 6/1/2011) 11.0 IEER (before 6/1/2011) 12.5 IEER (as of 6/1/2011)	
	≥240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.4 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.6 IEER (as of 6/1/2011)	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 12.4 IEER (as of 6/1/2011)	
	≥ 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.4 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.0 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 12.2 IEER (as of 6/1/2011)	
Air conditioners, evaporatively cooled	< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	AHRI 210/240
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER (before 6/1/2011) 12.1 EER (as of 6/1/2011) 11.7 IEER (before 6/1/2011) 12.3 IEER (as of 6/1/2011)	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
		All other	Split System and Single Package	11.3 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.5 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 12.0 EER (as of 6/1/2011) 11.2 IEER (before 6/1/2011) 12.2 IERR (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 11.8 EER (as of 6/1/2011) 11.0 IEER (before 6/1/2011) 12.0 IEER (as of 6/1/2011)	
	≥240,000 Btu/h and < 760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER (before 6/1/2011) 11.9 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 12.1 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 12.2 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 11.9 IEER (as of 6/1/2011)	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
	≥ 760,000 Btu/h	Electric Resistance (or None	Split System and Single Package	11.0 EER (before 6/1/2011) 11.7 EER (as of 6/1/2011) 11.1 IEER (before 6/1/2011) 11.9 IEER (as of 6/1/2011)	
		All other	Split System and Single Package	10.8 EER (before 6/1/2011) 11.5 EER (as of 6/1/2011) 10.9 IEER (before 6/1/2011) 11.7 IEER (as of 6/1/2011)	
Condensing units, air cooled	≥ 135,000 Btu/h	-		10.1 EER (before 6/1/2011) 10.5 EER (as of 6/1/2011) ((~~11.2 IPLV~~)) 11.4 IEER (before 6/1/2011) 11.8 IEER (as of 6/1/2011)	AHRI 365
Condensing units, water ((~~or evaporatively~~)) cooled	≥ 135,000 Btu/h	-		13.1 EER (before 6/1/2011) 13.5 EER (as of 6/1/2011) ((~~13.1 IPLV~~)) 13.6 IEER (before 6/1/2011) 14.0 IEER (as of 6/1/2011)	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	-		13.1 EER (before 6/1/2011) 13.5 EER (as of 6/1/2011) ((~~13.1 IPLV~~)) 13.6 IEER (before 6/1/2011) 14.0 IEER (as of 6/1/2011)	

a Reserved.

b IPLVs are only applicable to equipment with capacity modulation.

c Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

d Applies to all units, including single-phase and three-phase. For single-phase air-cooled air-conditioners < 65,000 Btu/h, SEER values are those set by NAECA.

e Reserved.

TABLE 14-1A(2)

Air Conditioners and Condensing Units Serving Computers Rooms

Minimum Efficiency Requirements

Equipment Type	Net Sensible Cooling Capacity[a]	Minimum SCOP-127[b] Efficiency Downflow units / Upflow units	Test Procedure

Equipment Type	Net Sensible Cooling Capacity[a]	Minimum SCOP-127[b] Efficiency Downflow units / Upflow units	Test Procedure
Air conditioners, air cooled	<65,000 Btu/h (<19 kW)	2.20 / 2.09	ANSI / ASHRAE 127
	>= 65,000 Btu/h and < 240,000 Btu/h (>=19kW and < 70 kW)	2.10 / 1.99	
	>= 240,000 Btu/h (>= 70 kW)	1.90 / 1.79	
Air conditioners, water cooled	<65,000 Btu/h (<19 kW)	2.60 / 2.49	ANSI / ASHRAE 127
	>= 65,000 Btu/h and < 240,000 Btu/h (>=19kW and < 70 kW)	2.50 / 2.39	
	>= 240,000 Btu/h (>= 70 kW)	2.40 /2.29	
Air conditioners, water cooled with fluid economizer	<65,000 Btu/h (<19 kW)	2.55 /2.44	ANSI / ASHRAE 127
	>= 65,000 Btu/h and < 240,000 Btu/h (>=19kW and < 70 kW)	2.45 / 2.34	
	>= 240,000 Btu/h (>= 70 kW)	2.35 / 2.24	
Air conditioners, glycol cooled (rated at 40% propylene glycol)	<65,000 Btu/h (<19 kW)	2.50 / 2.39	ANSI / ASHRAE 127
	>= 65,000 Btu/h and < 240,000 Btu/h (>=19kW and < 70 kW)	2.15 / 2.04	
	>= 240,000 Btu/h (>= 70 kW)	2.10 / 1.99	
Air conditioners, glycol cooled (rated at 40% propylene glycol) with fluid economizer	<65,000 Btu/h (<19 kW)	2.45 / 2.34	ANSI / ASHRAE 127
	>= 65,000 Btu/h and < 240,000 Btu/h (>=19kW and < 70 kW)	2.10 / 1.99	
	>= 240,000 Btu/h (>= 70 kW)	2.05 / 1.94	

a. Net sensible cooling capacity: The total gross cooling capacity less the latent cooling less the energy to the air movement system. (Total Gross – latent – Fan Power)

b. Sensible coefficient of performance (SCOP-127): a ratio calculated by dividing the net sensible cooling capacity in watts by the total power input in watts (excluding re-heaters and humidifiers) at conditions defined in ASHRAE Standard 127. The net sensible cooling capacity is the gross sensible capacity minus the energy dissipated into the cooled space by the fan system.

TABLE 14-1A(3)

Electrically Operated Variable Refrigerant Flow Air Conditioners

Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
VRF Air Conditioners, Air Cooled	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.2 EER 12.5 IEER 13.1 IEER (as of 7/1/2012)	
	≥135,000 Btu/h and <240,000	Electric Resistance	VRF Multi-split System	11.0 EER 12.3 IEER	

	Btu/h	(or none)		12.9 IEER (as of 7/1/2012)	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.0 EER 11.1 IEER 11.6 IEER (as of 7/1/2012)	

TABLE 14-1A(4)

Electrically Operated Variable Refrigerant Flow Air-to-Air and Applied Heat Pumps

Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 12.3 IEER 12.9 IEER (as of 7/1/2012)	
			VRF Multi-split		

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	System with Heat Recovery	10.8 EER 12.1 IEER 12.7 IEER (as of 7/1/2012)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.6 EER 11.8 IEER 12.3 IEER (as of 7/1/2012)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	10.4 EER 11.6 IEER 12.1 IEER (as of 7/1/2012)	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	9.5 EER 10.6 IEER 11.0 IEER (as of 7/1/2012)	
	≥240,000 Btu/h	Electric	VRF Multi-split System with	9.3 EER	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
		Resistance (or none)	Heat Recovery	10.4 IEER 10.8 IEER (as of 7/1/2012)	
VRF Water source (cooling mode)	<65,000 Btu/h	All	VRF Multi-split systems 86°F entering water	12.0 EER	AHRI 1230
	<65,000 Btu/h	All	VRF Multi-split systems with Heat Recovery 86°F entering water	11.8 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System 86°F entering water	12.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System with Heat Recovery	11.8 EER	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
			86°F entering water		
	≥135,000 Btu/h	All	VRF Multi-split System 86°F entering water	10.0 EER	
	≥135,000 Btu/h	All	VRF Multi-split System with Heat Recovery 86°F entering water	9.8 EER	
VRF Groundwater source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System 59°F entering water	16.2 EER	AHRI 1230
	<135,000 Btu/h	All	VRF Multi-split System with Heat Recovery 59°F entering water	16.0 EER	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
	≥135,000 Btu/h	All	VRF Multi-split System 59°F entering water	13.8 EER	
	≥135,000 Btu/h	All	VRF Multi-split System with Heat Recovery 59°F entering water	13.6 EER	
VRF Ground source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System 77°F entering water	13.4 EER	AHRI 1230
	<135,000 Btu/h	All	VRF Multi-split System with Heat Recovery 77°F entering water	13.2 EER	
	≥135,000 Btu/h	All	VRF Multi-split System 77°F entering water	11.0 EER	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
	≥135,000 Btu/h	All	VRF Multi-split System with Heat Recovery 77°F entering water	10.8 EER	
VRF Air Cooled (heating mode)	<65,000 Btu/h (cooling capacity)	- - -	VRF Multi-split System	7.7 HSPF	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	- - -	VRF Multi-split system 47°F db/43°F wb outdoor air	3.3 COP	
			17°F db/15°F wb outdoor air	2.25 COP	
	≥135,000 Btu/h (cooling capacity)	- - -	VRF Multi-split System 47°F db/43°F wb outdoor air	3.2 COP	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
			17°F db/15°F wb outdoor air	2.05 COP	
VRF Water source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	4.2 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	3.9 COP	
VRF Groundwater source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50°F entering water	3.6 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50°F entering water	3.3 COP	
VRF Ground source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32°F entering water	3.1 COP	

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32°F entering water	2.8 COP	AHRI 1230

TABLE 14-1B

UNITARY AND APPLIED HEAT PUMPS, ELECTRICALLY OPERATED,

MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
Air Cooled, (Cooling Mode)	< 65,000 Btu/h[d]	Split System	13.0 SEER	AHRI 210/240
		Single Package	13.0 SEER	
	≥65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	11.0 EER[c] 11.2 IEER[c]	AHRI 340/360
	≥135,000 Btu/h and <240,000 Btu/h	Split System and Single Package	10.6 EER[c] 10.7 IEER[c]	
	≥240,000 Btu/h	Split System and Single Package	9.5 EER[c] 9.6 IEER[c]	

Through-the-Wall (Air Cooled, Cooling Mode)	<30,000 Btu/h [d]	Split System	12.0 SEER	AHRI 210/240
		Single Package	12.0 SEER	
Water-Source (Cooling Mode)	< 17,000 Btu/h	86°F Entering Water	11.2 EER	AHRI/ISO-13256-1
	≥ 17,000 Btu/h and <65,000 Btu/h	86°F Entering Water	12.0 EER	AHRI/ISO-13256-1
	≥65,000 Btu/h and < 135,000 Btu/h	86°F Entering Water	12.0 EER	AHRI/ISO-13256-1
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	59°F Entering Water	16.2 EER	AHRI/ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	77°F Entering Water	13.4 EER	AHRI/ISO-13256-1
Air Cooled (Heating Mode)	< 65,000 Btu/h[d] (Cooling Capacity)	Split System	7.7 HSPF	AHRI 210/240
		Single Package	7.7 HSPF	
	≥65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air 17°F db/15°F wb Outdoor Air	3.3 COP 2.25 COP	
	≥135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air 17°F db/15°F wb Outdoor Air	3.2 COP 2.05 COP	AHRI 340/360
Through-the-Wall (Air	<30,000 Btu/h[d]	Split System	7.4 HSPF	AHRI 210/240

Cooled, Heating Mode)		Single Package	7.4 HSPF	
Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	68°F Entering Water	4.2 COP	AHRI/ISO-13256-1
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	50°F Entering Water	3.6 COP	AHRI/ISO-13256-1
Ground Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	32°F Entering Water	3.1 COP	AHRI/ISO-13256-1
Water-Source Water-to-Water (Cooling Mode)	< 135,000 Btu/h	86°F Entering Water	10.6 EER	AHRI/ISO-13256-2
Groundwater-Source Water-to-Water (Cooling Mode)	< 135,000 Btu/h	59°F Entering Water	16.3 EER	AHRI/ISO-13256-2
Ground Source Brine-to-Water (Cooling Mode)	< 135,000 Btu/h	77°F Entering Water	12.1 EER	AHRI/ISO-13256-2
Water-Source Water-to-Water (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	68°F Entering Water	4.2 COP	AHRI/ISO-13256-2
Groundwater-Source Water-to-Water (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	50°F Entering Water	3.6 COP	AHRI/ISO-13256-2

Ground Source Brine-to-Water (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	32°F Entering Water	3.1 COP	AHRI/ISO-13256-2

[a] Reserved.

[b] IPLVs and Part load rating conditions are only applicable to equipment with capacity modulation.

[c] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[d] Applies to all units, including single-phase and three-phase. For single-phase air-cooled heat pumps < 65,000 Btu/h, SEER and HSPF values are those set by NAECA.

[e] Reserved.

TABLE 14-1C

WATER CHILLING PACKAGES, MINIMUM EFFICIENCY REQUIREMENTS[a]

			PATH A[b]		PATH B[b]		
Equipment Type	**Size Category**	**Units**	**Full Load**	**IPLV**	**Full Load**	**IPLV**	**Test Procedure[a]**
Air-Cooled Chillers[e]	<150 tons	EER	>9.562	>12.500	NA[c]	NA[c]	AHRI 550/590-03
	≥150 tons	EER	>9.562	>12.750	NA[c]	NA[c]	
Air-Cooled Without Condenser, Electrically Operated[e]	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements					

Water-Cooled, Electrically Operated, Reciprocating	All Capacities	Reciprocating units must comply with water cooled positive displacement efficiency requirements					
Water-Cooled; Electrically Operated, Positive Displacement and Heat Recovery Chillers	<75 tons (larger sizes to comply with centrifugal requirements)	kW/ton	<0.780[f]	<0.630	<0.800[f]	<0.600	
	((~~≥75 tons and <150 tons~~	~~kW/ton~~	~~<0.775~~	~~<0.615~~	~~<0.790~~	~~<0.586~~	
	~~≥150 tons and <300 tons~~	~~kW/ton~~	~~<0.680~~	~~<0.580~~	~~<0.718~~	~~<0.540~~	
	~~≥300 tons~~	~~kW/ton~~	~~<0.620~~	~~<0.540~~	~~<0.639~~	~~<0.490~~))	
Water-Cooled, Electrically Operated, Centrifugal	<150 tons	kW/ton	<0.634[f]	<0.596	<0.639[f]	<0.450	
	≥150 tons and <300 tons	kW/ton	<0.634[f]	<0.596	<0.639[f]	<0.450	
	≥300 tons and <600 tons	kW/ton	<0.576[f]	<0.549	<0.600[f]	<0.400	
	≥600 tons	kW/ton	<0.570[f]	<0.539	<0.590[f]	<0.400	
Air-Cooled Absorption Single Effect	All Capacities	COP	>0.600	NR[d]	NA[c]	NA[c]	AHRI

Water-Cooled Absorption Single Effect	All Capacities	COP	>0.700	NR[d]	NA[c]	NA[c]	560-92
Absorption Double Effect	All Capacities	COP	>1.000	>1.050	NA[c]	NA[c]	
Absorption Double Effect Direct Fired	All Capacities	COP	>1.000	>1.000	NA[c]	NA[c]	

[a] The chiller equipment requirements do not apply for chillers used in low temperature applications where the design leaving fluid temperature is <38°F.

[b] Compliance with this standard can be obtained by meeting the minimum requirements of Path A or Path B. However, both the full and IPLV must be met to fulfill the requirements of Path A or Path B.

[c] NA means that this requirement is not applicable and cannot be used for compliance.

[d] NR means that there are no minimum requirements for this category.

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

[f] Full load efficiency requirements do not apply to positive displacement chillers used in condenser water heat recovery systems.

TABLE 14-1D

PACKAGED TERMINAL AIR CONDITIONERS,

PACKAGED TERMINAL HEAT PUMPS, ROOM AIR CONDITIONERS,

AND ROOM AIR CONDITIONER HEAT PUMPS, ELECTRICALLY OPERATED, MINIMUM EFFICIENCY

REQUIREMENTS

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
PTAC (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	12.5 - (0.213 x Cap/1000)[b] EER (before 10/08/2012) 13.8 - (0.300 × Cap/1000) [b] EER (as of 10/08/2012)	AHRI 310/380
		82°F db Outdoor Air	14.7 - (0.213 x Cap/1000)[b] EER	
PTAC (Cooling Mode) Nonstandard Size[c]	All Capacities	95°F db Outdoor Air	10.9 - (0.213 x Cap/1000)[b] EER	
		82°F db Outdoor Air	13.1 - (0.213 x Cap/1000)[b] EER	
PTHP (Cooling Mode) Standard Size	All Capacities	95°F db Outdoor Air	12.3 - (0.213 x Cap/1000)[b] EER (before 10/08/2012) 14.0 - (0.300 × Cap/1000) [b] EER (as of 10/08/2012)	
		82°F db Outdoor Air	14.5 - (0.213 x Cap/1000)[b] EER	
PTHP (Cooling Mode) Nonstandard Size[c]	All Capacities	95°F db Outdoor Air	10.8 - (0.213 x Cap/1000)[b] EER	
		82°F db Outdoor Air	13.0 - (0.213 x Cap/1000)[b] EER	

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
PTHP (Heating Mode) Standard Size	All Capacities		3.2 - (0.026 x Cap/1000)[b] COP (before 10/08//2012) 3.7 - (0.052 × Cap/1000) [b] COP (as of 10/08/2012)	
PTHP (Heating Mode) Nonstandard Size[c]	All Capacities		2.9 - (0.026 x Cap/1000)[b] COP	
SPVAC (Cooling Mode)	< 65,000 Btu/h	95°F db/75°F wb Outdoor Air	9.0 EER	AHRI 390
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb Outdoor Air	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb Outdoor Air	8.6 EER	
SPVHP (Cooling Mode)	< 65,000 Btu/h	95°F db/75°F wb Outdoor Air	9.0 EER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	95°F db/75°F wb Outdoor Air	8.9 EER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	95°F db/75°F wb Outdoor Air	8.6 EER	
SPVAC (Heating Mode)	< 65,000 Btu/h	47°F db/43°F wb Outdoor Air	3.0 COP	

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
	≥ 65,000 Btu/h and < 135,000 Btu/h	47°F db/43°F wb Outdoor Air	3.0 COP	
	≥ 135,000 Btu/h and < 240,000 Btu/h	47°F db/43°F wb Outdoor Air	2.9 COP	
Room Air Conditioners, with Louvered Sides	< 6,000 Btu/h		9.7 EER	ANSI/ AHAM RAC-1
	≥6,000 Btu/h and < 8,000 Btu/h		9.7 EER	
	≥ 8,000 Btu/h and < 14,000 Btu/h		9.8 EER	
	≥14,000 Btu/h and < 20,000 Btu/h		9.7 EER	
	≥20,000 Btu/h		8.5 EER	
Room Air Conditioners, without Louvered Sides	< 8,000 Btu/h		9.0 EER	
	≥8,000 Btu/h and < 20,000 Btu/h		8.5 EER	
	≥20,000 Btu/h		8.5 EER	
Room Air Conditioner Heat Pumps with Louvered Sides	< 20,000 Btu/h		9.0 EER	
	≥ 20,000 Btu/h		8.5 EER	

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[a]
Room Air Conditioner Heat Pumps without Louvered Sides	< 14,000 Btu/h		8.5 EER	
	≥ 14,000 Btu/h		8.0 EER	
Room Air Conditioner, Casement Only	All Capacities		8.7 EER	
Room Air Conditioner, Casement –Slider	All Capacities		9.5 EER	

[a] Reserved.

[b] Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

[c] Nonstandard size units must be factory labeled as follows: "MANUFACTURED FOR NONSTANDARD SIZE APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Nonstandard size efficiencies apply only to units being installed in existing sleeves having an external wall opening of less than 16-in. high or less than 42-in. wide, and having a cross-sectional area less than 670 in^2.

[d] Casement room air conditioners are not separate product classes under current minimum efficiency column.

[e] New room air conditioner standards, covered by NAECA became effective October 1, 2000.

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Table 14-1G

Performance Requirements for Heat Rejection Equipment

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Sub-Category or Rating Condition	Minimum Efficiency[b]	Test Procedure[c]
Propeller or Axial Fan, Open Circuit Cooling Towers	All propeller or axial fan; PLUS centrifugal fan ≥ 1100 gpm	95°F (35°C) Entering Water 85°F (29°C) Leaving Water 75°F (24°C) wb Outdoor Air	38.2 gpm/hp (3.23 L/s-kW)	CTI ATC-105 and CTI STD-201
Centrifugal Fan, Open Circuit Cooling Towers[d]	< 1100 gpm (larger sizes to comply with propeller/axial fan requirements) ((~~All~~))	95°F (35°C) Entering Water 85°F (29°C) Leaving Water 75°F (24°C) wb Outdoor Air	20.0 gpm/hp (1.7 L/s-kW)	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan, Closed Circuit Cooling Towers	All	102°F (39°C) Entering Water 90°F (32°C) Leaving Water 75°F (24°C) wb Outdoor Air	14.0 gpm/hp	CTI ATC-105S and CTI STD-201

Centrifugal Fan, Closed Circuit Cooling Towers	All	102°F (39°C) Entering Water 90°F (32°C) Leaving Water 75°F (24°C) wb Outdoor Air	7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Air Cooled Condensers	All	125°F (52°C) Condensing Temperature R22 Test Fluid 190°F (88°C) Entering Gas Temperature 15°F (8°C) Subcooling 95°F (35°C) Entering Drybulb	176,000 Btu/hhp 69 COP	AHRI 460

[a] For purposes of this table, open circuit cooling tower performance is defined as the process water flow rating of tower at thermal rating conditions listed in this table divided by the fan nameplate rated motor power.

[b] For purposes of this table, closed circuit cooling tower performance is defined as the process water flow rating of tower at thermal conditions listed in this table divided by the sum of fan motor nameplate power.

[c] For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan nameplate rated motor power.

[d] Centrifugal fan open-circuit cooling towers with a combined rated capacity of 1,100 gpm or greater at 95°F condenser water return, 85°F condenser water supply, and 75°F outdoor air wet-bulb temperature shall comply with the energy efficiency requirement for axial fan open-circuit cooling towers listed in Table 14-1G except for those that comply with the exception listed in Section 1438.1.2.

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