



RULE MAKING ORDER

(RCW 34.05.360)

CR-103 (7/22/01)

Agency: **State Building Code Council**

- Permanent Rule
- Emergency Rule
- Expedited Rule Making

(1) Date of Adoption: **November 9, 2001**

(2) Purpose:

To make changes to the Washington State Energy Code, Chapter 51-11 WAC.

(3) Citation of existing rules affected by this order:

Repealed:

Amended: WAC 51-11 Sections 502, 503, 530, 533, 534, 535, 536, 537, 601, 602, 603, 625, 626, 627, 628, 629, 630, 900, 1006, 1401, 1411, 1412, 1413, 1423, 1433, 1437, 1452, 1454

Suspended:

(4) Statutory authority for adoption: RCW 19.27A.025, 19.27A.045

Other authority:

PERMANENT RULE ONLY (Including Expedited Rule Making)

Adopted under notice filed as WSR 01-16-120 on July 31, 2001 (date).

Describe any changes other than editing from proposed to adopted version:

1. Section 530 (Table 5-1) was altered to provide a more permissive wall target component value for "Other Fuels."
2. Section 602.2 was altered to reflect equivalent wall constructions to meet the R-21 requirement.
3. Section 625 Option 1 was adopted for Tables 6-1 and 6-2.
4. Section 1413.4 an exception was added to provide consistency with DOH rules for health care facilities
5. Sections 1423 and 1433 proposed change to further restrict units without economizers total capacity was not adopted.

EMERGENCY RULE ONLY

Under RCW 34.05.350 the agency for good cause finds:

- (a) That immediate adoption, amendment, or repeal of a rule is necessary for the preservation of the public health, safety, or general welfare, and that observing the time requirements of notice and opportunity to comment upon adoption of a permanent rule would be contrary to the public interest.
- (b) That state or federal law or federal rule or a federal deadline for state receipt of federal funds requires immediate adoption of a rule.

(5.3) Any other findings required by other provisions of law as precondition to adoption or effectiveness of rule?

Yes No If Yes, explain:

(6) Effective date of rule:

Permanent Rules
or Expedited Rule Making

- 31 days after filing
- Other (specify): **July 1, 2002***

*(If less than 31 days after filing, specific finding in 5.3 under RCW 34.05.380(3) is required)

Emergency Rules

- Immediately
- Later (specify)

NAME (TYPE OR PRINT)

Jim Lewis

SIGNATURE

Jim Lewis for Jim Lewis

TITLE

Council Chair

DATE

December 18, 2001

CODE REVISER USE ONLY

CODE REVISER'S OFFICE
STATE OF WASHINGTON

DEC 18 2001

346

TIME _____ AM/PM

WSR 01-01-112

(COMPLETE REVERSE SIDE)

NOTE: If any category is left blank, it will be calculated as zero.

No descriptive text.

**Count by whole WAC sections only, from the WAC number through the history note.
A section may be counted in more than one category.**

The number of sections adopted in order to comply with:

Federal statute:	New	Amended	Repealed
Federal rules or standards:	New	Amended	Repealed
Recently enacted state statutes:	New	Amended	Repealed

The number of sections adopted at the request of a nongovernment entity:

New	0	Amended	28	Repealed	0
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The number of sections adopted on the agency's own initiative:

New		Amended		Repealed
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The number of sections adopted in order to clarify, streamline, or reform agency procedures:

New		Amended		Repealed
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The number of sections adopted using:

Negotiated rule making:	New	Amended	Repealed
Pilot rule making:	New	Amended	Repealed
Other alternative rule making:	New 0	Amended 28	Repealed 0

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0502 Building envelope requirements.

502.1 General:

502.1.1: The stated U- or F-factor of any component assembly, listed in Table 5-1 or 5-2, such as roof/ceiling, opaque wall or opaque floor may be increased and the U-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 specified in this Section.

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 21-29 in Standard RS-1 listed in Chapter 7, using the framing factors listed in Chapter 10 where applicable.

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

1. Results of laboratory or field measurements.
2. Standard RS-25, 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 24 of Standard RS-1, listed in Chapter 7.
4. Results of parallel path correction factors effective framing/cavity R-values as provided in Table 10-5A - EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY for metal stud walls and roof/ceilings.

502.1.2: For consideration of thermal mass effects, see section 402.4.

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

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

502.1.4 Insulation:

502.1.4.1 General: All insulating materials shall comply with sections 2602 and/or 707 of the Uniform Building Code. Substantial contact of the insulation with the surface being insulated is

required. All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities and maintain uniform R-values and shall be installed in a manner which will permit inspection of the manufacturer's R-value identification mark. To the maximum extent possible, insulation shall extend over the full component area to the intended R-value.

Alternatively, the thickness of roof/ceiling and wall insulation that is either blown in or spray-applied shall be identified by inches of thickness, density and R-value markers installed at least one for every 300 square feet (28 m²) through the attic, ceiling and/or wall space. In attics, the markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness and minimum settled thickness with numbers a minimum 1.0 inch (25 mm) in height. Each marker shall face the attic access. The thickness of installed attic insulation shall meet or exceed the minimum initial installed thickness shown by the marker. In cathedral ceilings and walls, the markers shall be affixed to the rafter and wall frame at alternating high and low intervals and marked with the minimum installed density and R-value with numbers a minimum 1.0 inch (25 mm) in height. Each marker shall face the conditioned room area.

502.1.4.2 Insulation Materials: All insulation materials including facings such as vapor barriers or breather papers installed within floor/ceiling assemblies, roof/ceiling assemblies, walls, crawl spaces, or attics shall have a flame spread rating of less than 25 and a smoke density not to exceed 450 when tested in accordance with UBC Standard 8-1.

EXCEPTIONS:

1. Foam plastic insulation shall comply with section 2602 of the Uniform Building Code.
2. When such materials are installed in concealed spaces of Types III, IV and V construction, the flame spread and smoke developed limitations do not apply to facing, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.
3. Cellulose insulation shall comply with section 707 of the Uniform Building Code.

502.1.4.3 Clearances: Where required, insulation shall be installed with clearances according to manufacturer's specifications. Insulation shall be installed so that required ventilation is unobstructed. For blown or poured loose fill insulation, clearances shall be maintained through installation of a permanent retainer.

502.1.4.4 Access Hatches and Doors: Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weatherstripped and insulated to a level equivalent to the insulation on the surrounding surfaces. Access shall be provided to all equipment which prevents damaging or compressing the insulation. A wood framed or equivalent baffle or retainer must be provided when loose fill insulation is installed, the purpose of which is to prevent the loose fill insulation from spilling into the living space when the attic access is opened, and to provide a permanent means of maintaining the installed R-value of the loose fill insulation.

502.1.4.5 Roof/Ceiling Insulation: Open-blown or poured loose

fill insulation may be used in attic spaces where the slope of the ceiling is not more than 3 feet in 12 and there is at least 30 inches of clear distance from the top of the bottom chord of the truss or ceiling joist to the underside of the sheathing at the roof ridge. When eave vents are installed, baffling of the vent openings shall be provided so as to deflect the incoming air above the surface of the insulation. Baffles shall be, rigid material, resistant to wind driven moisture. Requirements for baffles for ceiling insulation shall meet the Uniform Building Code section 1505.3 for minimum ventilation requirements. When feasible, the baffles shall be installed from the top of the outside of the exterior wall, extending inward, to a point 6 inches vertically above the height of noncompressed insulation, and 12 inches vertically above loose fill insulation.

502.1.4.6 Wall Insulation: Insulation installed in exterior walls shall comply with the provisions of this section. All wall insulation shall fill the entire framed cavity. Exterior wall cavities isolated during framing shall be fully insulated to the levels of the surrounding walls. All faced insulation shall be face stapled to avoid compression.

502.1.4.7 Floor Insulation: Floor insulation shall be installed in a permanent manner in substantial contact with the surface being insulated. Insulation supports shall be installed so spacing is no more than 24 inches on center. Foundation vents shall be placed so that the top of the vent is below the lower surface of the floor insulation.

EXCEPTION: Insulation may be omitted from floor areas over heated basements, heated garages or underfloor areas used as HVAC supply plenums. See Uniform Mechanical Code section 607 for underfloor supply plenum requirements. When foundation walls are insulated, the insulation shall be attached in a permanent manner. The insulation shall not block the airflow through foundation vents when installed. When foundation vents are not placed so that the top of the vent is below the lower surface of the floor insulation, a permanently attached baffle shall be installed at an angle of 30° from horizontal, to divert air flow below the lower surface of the floor insulation.

502.1.4.8 Slab-On-Grade: Slab-on-grade insulation, installed inside the foundation wall, shall extend downward from the top of the slab for a minimum distance of 24 inches or downward and then horizontally beneath the slab for a minimum combined distance of 24 inches. Insulation installed outside the foundation shall extend downward to a minimum of 24 inches or to the frostline. 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.

502.1.4.9 Radiant Slabs: The entire area of a radiant slab shall be thermally isolated from the soil, with a minimum of R-10 insulation. The insulation shall be an approved product for its intended use. If a soil gas control system is present below the radiant slab, which results in increased convective flow below the radiant slab, the radiant slab shall be thermally isolated from the sub-slab gravel layer.

502.1.4.10 Below Grade Walls: Below grade exterior wall insulation used on the exterior (cold) side of the wall shall extend from the top of the below grade wall to the top of the footing and shall be approved for below grade use. Above grade

insulation shall be protected.

Insulation used on the interior (warm) side of the wall shall extend from the top of the below grade wall to the below grade floor level.

502.1.5 Glazing and Door U-factors: Glazing and door U-factors shall be determined in accordance with sections 502.1.5.1 and 502.1.5.2. All products shall be labeled with the NFRC certified or default U-factor. The labeled U-factor shall be used in all calculations to determine compliance with this Code. Sealed insulating glass shall conform to, or be in test for, ASTM E-774-81 class A.

EXCEPTIONS:

1. For glazed wall systems, assemblies with all of the following features are deemed to satisfy the vertical glazing U-factor requirement in ((~~Table 6-1 through 6-6~~)) Table 6-1 or 6-2 options with vertical glazing U-0.40 and greater:

- a. Double glazing with a minimum 1/2 inch gap width, having a low-emissivity coating with $e=0.10$ maximum, with 90% minimum argon gas fill, and a non-aluminum spacer (as defined in footnote 1 to Table 10-6B), and
- b. Frame that is thermal break aluminum (as defined in footnote 9 to Table 10-6B), wood, aluminum clad wood, vinyl, aluminum clad vinyl, or reinforced vinyl.

The only labeling requirement for products using this exception shall be a description of the product and a label stating: "This product is deemed to satisfy the ((~~Table 6-1 through 6-6~~)) Table 6-1 or 6-2 vertical glazing U-factor requirement using the exception to Section 502.1.5 in the Washington State Energy Code."

2. For overhead glazing, assemblies with all of the following features are deemed to satisfy the overhead glazing U-factor requirement in ((~~all Table 6-1 through 6-6~~)) Table 6-1 or 6-2 options **except** the unlimited glazing area options (((~~Option VIII in Table 6-2, Option IX in Table 6-4, and Option VIII for Climate Zone 1 and Option IX for Climate Zone 2 in Table 6-6~~))) (Option III in Table 6-1 and Option IV in Table 6-2):

- a. Either, double glazing with a minimum 1/2 inch gap width, having a low-emissivity coating with $e=0.20$ maximum, with 90% minimum argon gas fill, or, triple glazed plastic domes, and
- b. Frame that is thermal break aluminum (as defined in footnote 9 to Table 10-6B), wood, aluminum clad wood, vinyl, aluminum clad vinyl, or reinforced vinyl.

The only labeling requirement for products using this exception shall be a description of the product and a label stating: "This product is deemed to satisfy the ((~~Table 6-1 through 6-6~~)) Table 6-1 or 6-2 overhead glazing U-factor requirement using the exception to Section 502.1.5 in the Washington State Energy Code."

3. For solariums with a floor area which does not exceed 300 square feet, assemblies which comply with the features listed in exception 2 are deemed to satisfy the vertical glazing and overhead glazing U-factor requirement in ((~~Table 6-1 through 6-6~~)) Table 6-1 or 6-2 options with vertical glazing U-0.40 and greater.

The only labeling requirement for products using this exception shall be a description of the product and a label stating: "This product is deemed to satisfy the ((~~Table 6-1 through 6-6~~)) Table 6-1 or 6-2 vertical glazing and overhead glazing U-factor requirements using the exception to Section 502.1.5 in the Washington State Energy Code."

502.1.5.1 Standard Procedure for Determination of Glazing U-factors: U-factors for glazing shall be determined, certified and labeled in accordance with the National Fenestration Rating Council (NFRC) Product Certification Program (PCP), as authorized by an independent certification and inspection agency licensed by the NFRC. Compliance shall be based on the Residential Model Size. Product samples used for U-factor determinations shall be production line units or representative of units as purchased by the consumer or contractor. Products that are listed in the NFRC Certified Products Directory or certified to the NFRC standard shall not use default values.

EXCEPTIONS:

1. Glazing products without NFRC ratings may be assigned default U-factors from Table 10-6A for vertical glazing and from Table 10-6E for overhead glazing.

2. Units without NFRC ratings produced by a small business may be assigned default U-factors from Table 10-6A for garden windows, from Table 10-6B for other vertical glazing, and from Table 10-6E for overhead glazing.

502.1.5.2 Standard Procedure for Determination of Door U-factors: All doors, including fire doors, shall be assigned default U-factors from Table 10-6C.

- EXCEPTIONS:
1. U-factors determined, certified and labeled in accordance with the National Fenestration Rating Council (NFRC) Product Certification Program (PCP), as authorized by an independent certification and inspection agency licensed by the NFRC.
 2. The default values for the opaque portions of doors shall be those listed in Table 10-6C, provided that the U-factor listed for a door with a thermal break shall only be allowed if both the door and the frame have a thermal break.
 3. One unlabeled or untested exterior swinging door with the maximum area of 24 square feet may be installed for ornamental, security or architectural purposes. Products using this exception shall not be included in ~~((either))~~ the U-factor ~~((or glazing area))~~ calculation requirements, however glazing area shall be included in glazing area calculations.

502.1.6 Moisture Control:

502.1.6.1 Vapor Retarders: Vapor retarders shall be installed on the warm side (in winter) of insulation as specified in the following cases.

EXCEPTION: Vapor retarder installed with not more than 1/3 of the nominal R-value between it and the conditioned space.

502.1.6.2 Floors: Floors separating conditioned space from unconditioned space shall have a vapor retarder installed. The vapor retarder shall have a one perm dry cup rating or less (i.e., four mil [0.004 inch thick] polyethylene or kraft faced material).

502.1.6.3 Roof/Ceilings: 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. Faced batt insulation where used as a vapor retarder shall be face stapled. Single rafter joist vaulted ceiling cavities shall be of sufficient depth to allow a minimum one inch vented air space above the insulation.

502.1.6.4: Vapor retarders shall not be required in roof/ceiling assemblies where the ventilation space above the insulation averages 12 inches or greater.

502.1.6.5: Vapor retarders shall not be required where all of the insulation is installed between the roof membrane and the structural roof deck.

502.1.6.6 Walls: Walls separating conditioned space from unconditioned space shall have a vapor retarder installed. Faced batt insulation shall be face stapled.

502.1.6.7 Ground Cover: A ground cover of six mil (0.006 inch thick) black polyethylene or approved equal shall be laid over the ground within crawl spaces. The ground cover shall be overlapped 12 inches minimum at the joints and shall extend to the foundation wall.

EXCEPTION: The ground cover may be omitted in crawl spaces if the crawl space has a concrete slab floor with a minimum thickness of 3-1/2 inches.

502.2 Thermal Criteria for Group R Occupancy:

502.2.1 UA Calculations: The proposed UA as calculated using Equations 2 and 3 shall not exceed the target UA as calculated

using Equation 1. For the purpose of determining equivalent thermal performance, the glazing area for the target UA shall be calculated using values in Table 5-1. The opaque door area shall be the same in the target UA and the proposed UA.

EXCEPTION: Log and solid timber walls that have a minimum average thickness of 3.5" and with space heat type other than electric resistance, are exempt from wall target UA and proposed UA calculations.

502.2.2 Space Heat Type: The following two categories comprise all space heating types:

1. Electric Resistance: Space heating systems which include baseboard units, radiant units and forced air units as either the primary or secondary heating system.

EXCEPTION: Electric resistance systems for which the total electric heat capacity in each individual dwelling unit does not exceed the greater of: 1) One thousand watts (1000 w) per dwelling unit, or; 2) One watt per square foot (1 w/ft²) of the gross floor area.

2. Other: All gas, wood, oil and propane space heating systems, unless electric resistance is used as a secondary heating system, and all heat pump space heating systems. (See EXCEPTIONS, Electric Resistance, section 502.2.2 above.)

502.3 Reserved.

502.4 Air Leakage:

502.4.1 General: The requirements of this section shall apply to all buildings and structures, or portions thereof, and only to those locations separating outdoor ambient conditions from interior spaces that are heated or mechanically cooled.

502.4.2 Doors and Windows, General: Exterior doors and windows shall be designed to limit air leakage into or from the building envelope. Site-constructed doors and windows shall be sealed in accordance with Section 502.4.3.

502.4.3 Seals and Weatherstripping:

a. Exterior joints around windows and door frames, openings between walls and foundation, between walls and roof and wall panels; openings at penetrations of utility services through walls, floors and roofs; and all other openings in the building envelope for all occupancies and all other openings in between units in R-1 occupancy shall be sealed, caulked, gasketed or weatherstripped to limit air leakage. Other exterior joints and seams shall be similarly treated, or taped, or covered with moisture vapor permeable housewrap.

b. All exterior doors or doors serving as access to an enclosed unheated area shall be weatherstripped to limit leakage around their perimeter when in a closed position.

c. Site built windows are exempt from testing but shall be made tight fitting. Fixed lights shall have glass retained by stops with sealant or caulking all around. Operating sash shall have weatherstripping working against overlapping trim and a closer/latch which will hold the sash closed. The window frame to framing crack shall be made tight with caulking, overlapping

membrane or other approved technique.

d. Openings that are required to be fire resistive are exempt from this section.

502.4.4 Recessed Lighting Fixtures: When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.

2. Type IC rated, installed inside a sealed box constructed from a minimum 1/2 inch thick gypsum wall board, or constructed from a preformed polymeric vapor barrier, or other air tight assembly manufactured for this purpose.

3. Type IC rated, certified under ASTM E283 to have no more than 2.0 cfm air movement from the conditioned space to the ceiling cavity. The lighting fixture shall be tested at 75 Pascals or 1.57 lbs/ft² pressure difference and have a label attached, showing compliance.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0503 Building mechanical systems.

503.1 General: This section covers the determination of design requirements, system and component performance, control requirements, insulating systems and duct construction.

503.2 Calculations of Heating and Cooling Loads, and System Sizing Limits: The design parameters specified in Chapter 3 shall apply for all computations.

503.2.1 Calculation Procedures: Heating and cooling design loads for the purpose of sizing HVAC systems are required and shall be calculated in accordance with accepted engineering practice, including infiltration and ventilation.

503.2.2 Space Heating and Space Cooling System Sizing Limits: Building mechanical systems for all buildings which provide space heating and/or space cooling shall be sized no greater than two hundred percent (200%) of the heating and cooling design loads as calculated above.

EXCEPTIONS: 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 equipment which provides both heating and cooling in one package unit, including heat pumps with electric heating and cooling and gas-pack units with gas heating and electric cooling, compliance need only be demonstrated for either the space heating or space cooling system size.

2. Natural gas- or oil-fired space heating equipment whose total rated space heating output in any one dwelling unit is

a. 40,000 Btu/h or less is exempt from the sizing limit,

b. larger than 40,000 Btu/h may exceed the two hundred (200%) percent sizing limit provided that the installed equipment has an annual fuel utilization efficiency (AFUE) of not less than ninety (90%) percent.

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

503.3 Simultaneous Heating and Cooling: Systems and equipment that provide simultaneous heating and cooling shall comply with the requirements in, as appropriate, Section 1422 or Section 1435.

503.4 HVAC Equipment Performance Requirements: All heating equipment shall meet the requirements of the 1987 National Appliance Energy Conservation Act (NAECA) and be so labeled. Equipment shall also comply with Section 1411.

~~(503.4.1 Equipment Components:~~

~~503.4.1.1: The requirements of this section apply to equipment and mechanical component performance for heating, ventilating and air-conditioning systems. Equipment efficiency levels are specified. Data furnished by the equipment supplier or certified under a nationally recognized certification program or rating procedure shall be used to satisfy these requirements. Equipment efficiencies shall be based on the standard rating conditions in Tables 5-4, 5-5 or 5-6 as appropriate.~~

~~503.4.1.2: Where components from more than one manufacturer are assembled into systems regulated under this section, compliance for each component shall be as specified in sections 503.4.2 through 503.4.6 of this Code.~~

~~503.4.2. HVAC System Heating Equipment Heat Pump-heating Mode. Heat pumps whose energy input is entirely electric shall have a coefficient of performance (COP) heating, not less than the values in Table 5-7. Heat Pumps with supplementary backup heat other than electricity shall meet the requirements of Table 5-7.~~

~~503.4.2.1: These requirements apply to, but are not limited to, unitary (central) heat pumps (air source and water source) in the heating mode, water source (hydronic) heat pumps as used in multiple-unit hydronic HVAC systems, and heat pumps in the packaged terminal air-conditioner in the heating mode.~~

~~503.4.2.3 Supplementary Heater: The heat pump shall be installed with a control to prevent supplementary backup heater operation when the operating load can be met by the heat pump compression cycle alone.~~

~~503.4.2.4 Heat Pump Controls: Requirements for heat pump controls are listed in section 503.8.3.5 of this Code.~~

~~503.4.3 HVAC System Combustion Equipment: For Group R Occupancy, all gas, oil, and propane central heating systems shall have a minimum AFUE of 0.78. All other Group R Occupancy heating equipment fueled by gas, oil, or propane shall be equipped with an intermittent ignition device, or shall comply with the efficiencies as required in the 1987 National Appliances Energy Conservation Act~~

~~(Public Law 100-12).~~

~~HVAC Heating system efficiency trade offs shall be made using Chapters 4 or 6 of this Code.~~

~~503.4.4 Packaged and Unitary HVAC System Equipment, Electrically Operated, Cooling Mode: HVAC system equipment as listed below, whose energy input in the cooling mode is entirely electric, shall have an energy efficiency ratio (EER) or a seasonal energy efficiency ratio (SEER) cooling not less than values in Table 5-8.~~

~~503.4.4.1: These requirements apply to, but are not limited to, unitary (central) and packaged terminal heat pumps (air source and water source); packaged terminal air conditioners.~~

~~503.4.5 Other HVAC Equipment: HVAC equipment, other than that addressed in Sections 503.4.2 through 503.4.4, shall have a minimum performance at the specified rating conditions not less than the values shown in Tables 14-1 through 14-3.)~~

503.5 Reserved.

503.6 Balancing: The HVAC system design shall provide a means for balancing air and water systems. Balancing the system shall include, but not be limited to, dampers, temperature and pressure test connections and balancing valves.

503.7 Cooling with Outdoor Air (Economizer Cycle): Systems and equipment that provide mechanical cooling shall comply with Section 1413 and, as appropriate, Section 1423 or 1433.

503.8 Controls:

503.8.1 Temperature Control: Each system shall be provided with at least one adjustable thermostat for the regulation of temperature. Each thermostat shall be capable of being set by adjustment or selection of sensors as follows:

503.8.1.1: When used to control heating only: Fifty-five degrees to seventy-five degrees F.

503.8.1.2: When used to control cooling only: Seventy degrees to eighty-five degrees F.

503.8.1.3: When used to control both heating and cooling, it shall be capable of being set from fifty-five degrees to eighty-five degrees F and shall be capable of operating the system heating and cooling in sequence. The thermostat and/or control system shall have an adjustable deadband of not less than ten degrees F.

503.8.2 Humidity Control: If a system is equipped with a means for adding moisture to maintain specific selected relative humidities in space or zones, a humidistat shall be provided. Humidistats shall be capable of being set to prevent new energy from being used to produce space-relative humidity above thirty percent.

EXCEPTION: Special uses requiring different relative humidities may be permitted when approved by the building official.

503.8.3 Zoning for Temperature Control:

503.8.3.1 One- and Two-Family Dwellings: At least one thermostat for regulation of space temperature shall be provided for each separate system. In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each zone or floor.

503.8.3.2 Multifamily Dwellings: For multifamily dwellings, each individual dwelling unit shall have at least one thermostat for regulation of space temperature. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each room. Spaces other than living units shall meet the requirements of 503.8.3.3.

503.8.3.3 Reserved.

503.8.3.4 Control Setback and Shut-off:

Residential Occupancy Groups. One- and Two-Family and Multifamily dwellings--The thermostat required in section 503.8.3.1 or section 503.8.3.2, or an alternate means such as a switch or clock, shall provide a readily accessible, manual or automatic means for reducing the energy required for heating and cooling during the periods of non-use or reduced need, such as, but not limited to unoccupied periods and sleeping hours. Lowering thermostat set points to reduce energy consumption of heating systems shall not cause energy to be expended to reach the reduced setting.

503.8.3.5 Heat Pump Controls: Programmable thermostats are required for all heat pump systems. The cut-on temperature for the compression heating shall be higher than the cut-on temperature for the supplementary heat, and the cut-off temperature for the compression heating shall be higher than the cut-off temperature for the supplementary heat. Heat pump thermostats will be capable of providing at least two programmable setback periods per day. The automatic setback thermostat shall have the capability of limiting the use of supplemental heat during the warm-up period.

503.9 Air Handling Duct System Insulation: Ducts, plenums and enclosures installed in or on buildings shall be thermally insulated per Table 5-11.

EXCEPTIONS:

Duct insulation (except where required to prevent condensation) is not required in any of the following cases:

1. When the heat gain or loss of the ducts, without insulation, will not increase the energy requirements of the building.
2. Within the HVAC equipment.
3. Exhaust air ducts.
4. Supply or return air ducts installed in unvented crawl spaces with insulated walls, basements, or cellars in one- and two-family dwellings.

503.10 Duct Construction: All duct work shall be constructed in accordance with Standards RS-15, RS-16, RS-17, RS-18, RS-19 or RS-20, as applicable, and the Uniform Mechanical Code.

503.10.1 Leakage Testing: High-pressure and medium-pressure ducts shall be leak tested in accordance with the applicable

standards in Chapter 7 of this Code with the rate of air leakage not to exceed the maximum rate specified in that standard.

503.10.2 Seams and Joints: All low-pressure supply and return, including enclosed stud bays or joist cavities/space used to transport air, shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes installed in accordance with the manufacturer's installation instructions. Tapes and mastics used with rigid fibrous glass ducts shall be listed and labeled in accordance with UL 181A. Tapes and mastics used with flexible air ducts shall be listed and labeled in accordance with UL 181B. Duct tape is not permitted as a sealant on any ducts.

EXCEPTION: Ducts or building cavities used for air distribution that are located entirely within the conditioned space of the building are exempt from this section.

503.10.3 Dampers: Requirements for Automatic or manual dampers are found in the Washington State Ventilation and Indoor Air Quality Code.

503.10.4 Duct Insulation: Ducts shall meet the insulation requirements specified in Table 5-11.

503.11 Pipe Insulation: All piping shall be thermally insulated in accordance with Table 5-12.

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 (chapter 51-46 WAC).

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0530 Table 5-1.

**TABLE 5-1
TARGET COMPONENT VALUES FOR GROUP R OCCUPANCY**

Component	((Electric Resistance))		((Other Fuels	
	Climate Zone		Climate Zone	
	1	2	†	2
Glazing % Floor Area	15%	15%	±5%	±5%
Vertical Glazing U-Factor	U = 0.400	U = 0.400	U = 0.650	U = 0.600
Overhead Glazing U-Factor	U = 0.58	U = 0.58	U = 0.68	U = 0.64
Doors	U = 0.200 (R-5)	U = 0.200 (R-5)	U = 0.400 (R-2.5)	U = 0.400 (R-2.5)

Ceilings Attic	U = 0.031 (R-38)	U = 0.031 (R-38)	U = 0.036 (R-30)	U = 0.031 (R-38)
Single Rafter/ Joist Vaulted	U = 0.034 (R-30)	U = 0.034 (R-30)	U = 0.034 (R-30)	U = 0.034 (R-30)
Walls ² <u>Space Heat Type:</u> <u>Electric Resistance</u> <u>Other</u>	U = 0.058 (R-19A) U = 0.062 ¹ (R-19)	U = 0.044 (((R-19+5A))) (R-19A + R-5) U = 0.062 ¹ (R-19)	U = 0.062 ⁷ (R-19)	U = 0.062 ⁷ (R-19)
Floors	U = 0.029 (R-30)	U = 0.029 (R-30)	U = 0.041 (R-19)	U = 0.029 (R-30)
Slab on Grade Slab R-Value	F = 0.54 (R-10)	F = 0.54 (R-10)	F = 0.54 (R-10)	F = 0.54 (R-10)
Below Grade Interior				
Wall R-Value	R-19	R-19	R-19	R-19
2' Depth: Walls Slab	U = 0.043 F = 0.69	U = 0.043 F = 0.69	U = 0.043 F = 0.69	U = 0.043 F = 0.69
3.5' Depth: Walls Slab	U = 0.041 F = 0.64	U = 0.041 F = 0.64	U = 0.041 F = 0.64	U = 0.041 F = 0.64
7' Depth: Walls Slab	U = 0.037 F = 0.57	U = 0.037 F = 0.57	U = 0.037 F = 0.57	U = 0.037 F = 0.57
Below Grade Exterior				
Wall R-Value	R-10	R-12	R-10	R-12
2' Depth: Walls Slab	U = 0.070 F = 0.60	U = 0.061 F = 0.60	U = 0.070 F = 0.60	U = 0.061 F = 0.60
3.5' Depth: Walls Slab	U = 0.064 F = 0.57	U = 0.057 F = 0.57	U = 0.064 F = 0.57	U = 0.057 F = 0.57
7' Depth: Walls Slab	U = 0.056 F = 0.42	U = 0.050 F = 0.42	U = 0.056 F = 0.42	U = 0.050 F = 0.42))

1. Log and Solid Timber walls that have a minimum average thickness of 3.5" are exempt from wall target UA and proposed UA calculations.
2. "A" means advanced framing. For more information, see Section 1005.2.

AMENDATORY SECTION (Amending WSR 92-01-140, filed 12/19/91, effective 7/1/92)

WAC 51-11-0533 Table 5-4--Reserved.

**((HVAC SYSTEM HEATING EQUIPMENT (HEAT PUMPS)
ELECTRICALLY OPERATED STANDARD RATING CONDITIONS**

TYPE		
CONDITIONS	AIR SOURCE	WATER SOURCE

Air entering equipment	°F	70°F (dry bulb)	70°F (dry bulb)	70°F (dry bulb)
Outdoor unit ambient	°F	47°F (dry bulb) /43°F (wet bulb)	17°F (dry bulb) -15°F (wet bulb)	-----
Entering water temp.	°F	-----60°F		
Water flow rate		-----As used in cooling		

Standard ratings are at sea level.))

AMENDATORY SECTION (Amending WSR 92-01-140, filed 12/19/91, effective 7/1/92)

WAC 51-11-0534 Table 5-5--Reserved.

((HVAC SYSTEM EQUIPMENT, ELECTRICALLY DRIVEN
STANDARD RATING CONDITIONS--COOLING

		TEMPERATURES			
		DRY BULB	WET BULB	INLET	OUTLET
Air entering equipment	°F	80°	67°	----	----
Condenser ambient (air cooled)	°F	95°	75°	----	----
Condenser water (water cooled)	°F	----	----	85°	95°

Standard ratings are at sea level.))

AMENDATORY SECTION (Amending WSR 92-01-140, filed 12/19/91, effective 7/1/92)

WAC 51-11-0535 Table 5-6--Reserved.

((APPLIED HVAC SYSTEM COMPONENTS ELECTRICALLY DRIVEN
STANDARD RATING CONDITIONS -- COOLING

ITEM		CENTRIFUGAL OR SELF-CONTAINED RECIPROCATING WATER CHILLER	CONDENSERLESS RECIPROCATING WATER-CHILLER
((Water Temperature,	°F		
— Leaving chilled		44°	44°
— Entering chilled		54°	54°
— Leaving condenser		95°	=
— Entering		85°	=
Fouling Factor, Water			
— Nonferrous tubes		0.0005*	0.0005
— Steel tubes		0.0010*	0.0010
— Refrigerant		0.0000*	0.0000
Condenser Ambient		95°F (dry bulb)	
— (air/evap. cooled)	°F	75°F (wet bulb)	=
Compressor saturated discharge temperature			
— Water cooled			
— (evap. cooled)	°F	=	105°
— Air cooled	°F	=	120°

Standard ratings at sea level:
 * hr • ft² • °F/Btu))

AMENDATORY SECTION (Amending WSR 92-01-140, filed 12/19/91, effective 7/1/92)

WAC 51-11-0536 Table 5-7--Reserved.

((MINIMUM HEAT PUMP EFFICIENCIES, HEATING MODE[†]

SOURCE	MINIMUM COP	MINIMUM HSPF
Air Source:		
— Split System	3.0 [‡]	6.8
— Single Package System	3.0 [‡]	6.6
Water Source	3.8 [‡]	=
Ground Source	3.0 [‡]	=

[†]—When tested at the standard rating specified in Table 5-4.

[‡]—When tested @ 47°F (dry bulb)/43°F (wet bulb)

[§]—@ 70°F entering

† (@ 50°F entering)

AMENDATORY SECTION (Amending WSR 92-01-140, filed 12/19/91, effective 7/1/92)

WAC 51-11-0537 Table 5-8--Reserved.

((MINIMUM EFFICIENCY FOR ELECTRIC HVAC EQUIPMENT;
COOLING

STANDARD RATING CAPACITY	AIR COOLED		EVAP/ WATER COOLED
	SEER	EER	EER
Under 65,000 Btu/hr. — (19,050 watts)			
A. Split System	10.0	=	=
B. Single Package [‡]	9.7	=	9.3 [†]
65,000 Btu/hr. and over	=	8.9 [‡]	10.5 [†]

[†] @ 80°F dry bulb / 67°F wet bulb

[‡] @ 95°F dry bulb

[‡] Prior to January 1, 1993 a minimum value of 8.0 SEER may be used.)

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0601 Scope.

601.1 General: This chapter establishes design criteria in terms of prescribed requirements for building construction.

The provisions of this chapter are applicable to all Group R Occupancies. Occupancies shall comply with all the requirements of Chapter 5 except for the modifications herein specified.

For wood frame assemblies, the building envelope requirements of this chapter may be met by installing one of the prescriptive packages in ((~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2). Installed components shall meet the requirements of section 602. Compliance with nominal R-Values shall be demonstrated for the thermal resistance of the added insulation in framing cavities and/or

insulated sheathing only and shall not include the thermal transmittance of other building materials or air films, but shall permit interruption by occasional framing members. Other than wood frame assemblies with continuous insulation uninterrupted by framing shall also be allowed to comply with nominal R-values.

For metal frame assemblies, compliance shall be demonstrated in accordance with Chapter 4 or Chapter 5 based on the assemblies in Chapter 10. Compliance with nominal R-values is not allowed, unless the full nominal R-value of the insulation is installed either inside or outside of the framing and is uninterrupted by framing.

AMENDATORY SECTION (Amending WSR 98-03-003, filed 1/8/98, effective 7/1/98)

WAC 51-11-0602 Building envelope requirements for Group R Occupancy.

602.1 Roof/Ceiling: Ceilings below vented attics and single-rafter, joist-vaulted ceilings shall be insulated to not less than the nominal R-value specified for ceilings in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2 as applicable.

602.2 Exterior Walls Both Above and Below Grade: Above grade exterior walls shall be insulated to not less than the nominal R-value specified in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2 as applicable. The following walls should be considered to meet (~~R-19~~) R-21 without additional documentation:

1. 2 x 6 framed and insulated with (~~R-19~~) R-21 fiberglass batts.
2. 2 x 4 framed and insulated with (~~R-13~~) R-15 fiberglass batts plus (~~R-3.2~~) R-4.0 foam sheathing.
3. 2 x 4 framed and insulated with (~~R-11~~) R-13 fiberglass batts plus R-5.0 foam sheathing.

602.3 Exterior Walls (Below Grade): Below grade exterior walls surrounding conditioned space shall be insulated to not less than the nominal R-value specified for below grade walls in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2 as applicable.

602.4 Slab-on-grade Floors: Slab-on-grade floors shall be insulated along their perimeter to not less than the nominal R-values specified for slab-on-grade floors in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2 as applicable. Slab insulation shall be installed in compliance with section 502.1.4.8. See Chapter 5, section 502.1.4.9, for additional requirements for radiant slab heating.

602.5 Floors Over Unconditioned Space: Floors over unconditioned spaces, such as vented crawl spaces, unconditioned

basements, and parking garages shall be insulated to not less than the nominal R-value shown for floors over unconditioned spaces, in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2.

602.6 Exterior Doors: Doors shall comply with Sections 602.6.1 and 602.6.2.

EXCEPTIONS:

1. Doors whose area and U-factor are included in the calculations for compliance with the requirements for glazing in section 602.7 shall be exempt from the door U-factor requirements prescribed in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2.

2. One unlabeled or untested exterior swinging door with the maximum area of 24 square feet may be installed for ornamental, security or architectural purposes. Products using this exception shall not be included in either the U-factor or glazing area calculation requirements.

602.6.1 Exterior Door Area: For half-lite and full-lite doors, the glazing area shall be included in calculating the allowed total glazing area in Section 602.7.1. Single glazing used for ornamental, security or architectural purposes shall be calculated using the exception to Section 602.7.2.

602.6.2 Exterior Door U-Factor: Doors, including fire doors, shall have a maximum area weighted average U-factor not exceeding that prescribed in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2.

602.7 Glazing:

602.7.1 Glazing Area: The total glazing area as defined in Chapter 2 shall not exceed the percentage of gross conditioned floor area specified in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2. This area shall also include any glazing in doors.

602.7.2 Glazing U-Factor: The total glazing area as defined in Chapter 2 shall have an area weighted average U-factor not to exceed that specified in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2. U-factors for glazing shall be determined in accordance with section 502.1.5. These areas and U-factors shall also include any doors using the exception of section 602.6.

If the U-factors for all vertical and overhead glazing products are below the appropriate U-factor specified, then no calculations are required. If compliance is to be achieved through an area weighted calculation, then the areas and U-factors shall be included in the plans submitted with a building permit application.

EXCEPTION:

Single glazing for ornamental, security, or architectural purposes and double glazed garden windows with a wood or vinyl frame shall be exempt from the U-factor calculations but shall have its area (~~doubled~~) tripled and shall be included in the percentage of the total glazing area as allowed for in (~~Tables 6-1 to 6-6~~) Table 6-1 or 6-2. The maximum area (before (~~doubling~~) tripling) allowed for the total of all single glazing and garden windows is one percent of the floor area.

602.8 Air Leakage For Group R Occupancy: The minimum air leakage control measures shall be as specified in section 502.4 as applicable.

AMENDATORY SECTION (Amending WSR 94-05-059, filed 2/10/94, effective 4/1/94)

WAC 51-11-0603 Building mechanical systems for Group R Occupancy.

603.1: Group R Occupancies that are space heated by air-to-air, ground-to-air, or water-to-air heat pumps shall comply with (~~Table 6-2 or 6-4 or 6-6 for other fuels~~) Table 6-1 or 6-2. System sizing shall be determined by an analysis consistent with section 503.2 of this Code, or, when approved by the building official, Chapter 9. All mechanical equipment efficiencies and service water heating system efficiencies shall comply with standards as stated in sections 503 and 504 of this Code.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0625 Table 6-1.

**((TABLE 6-1
PRESCRIPTIVE REQUIREMENTS* FOR GROUP R OCCUPANCY
CLIMATE ZONE 1 • HEATING BY ELECTRIC RESISTANCE**

Option	Glazing Area ¹⁰ % of Floor	Glazing U-Factor		Door ⁹ U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall Above Grade	Wall ⁸ int ⁸ Below Grade	Wall ⁸ ext ⁸ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical	Overhead ¹¹								
I.	10%	0.46	0.58	0.40	R-38	R-30	R-21	R-21	R-10	R-30	R-10
II.	12%	0.43	0.58	0.20	R-38	R-30	R-19	R-19	R-10	R-30	R-10
III.	12%	0.40	0.58	0.40	R-38	R-30	R-21	R-21	R-10	R-30	R-10
IV.*	15%	0.40	0.58	0.20	R-38	R-30	R-19	R-19	R-10	R-30	R-10
V.	18%	0.39	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
VI.	21%	0.36	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
VII. ⁷	25%	0.32 ⁷	0.58	0.20	R-38	R-30	R-19 ±R-5 ⁸	R-21	R-10	R-30	R-10
VIII. ⁷	30%	0.29 ⁷	0.58	0.20	R-38	R-30	R-19 ±R-5 ⁸	R-21	R-10	R-30	R-10

* Reference Case

** Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.

1. Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.

2. Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.

3. Requirement applicable only to single rafter or joist vaulted ceilings.

4. Below grade walls shall be insulated either on the exterior to a minimum level of R-10, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.

5. Floors over crawl spaces or exposed to ambient air conditions.

6. Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.

7. The following options shall be applicable to buildings less than three stories: 0.35 maximum for glazing areas of 25% or less; 0.32 maximum for glazing areas of 30% or less.

8. This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.

9. Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.

10. Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.040 or less is not included in glazing area limitations.

11. Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.))

**TABLE 6-1
PRESCRIPTIVE REQUIREMENTS^{0,1} FOR GROUP R OCCUPANCY
CLIMATE ZONE 1**

Option	Glazing Area ¹⁰ : % of Floor	Glazing U-Factor		Door ⁹ U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall ¹² Above Grade	Wall● int ⁴ Below Grade	Wall● ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical	Overhead ¹¹								
I.	12%	0.35	0.58	0.20	R-38	R-30	R-15	R-15	R-10	R-30	R-10
II.*	15%	0.40	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10
III.	Unlimited Group R-3 Occupancy only	0.40	0.58	0.20	R-38	R-30	R-21	R-21	R-10	R-30	R-10

* Reference Case

**TABLE 6-2
PRESCRIPTIVE REQUIREMENTS^{0,1} FOR GROUP R OCCUPANCY
CLIMATE ZONE 2**

Option	Glazing Area ¹⁰ : % of Floor	Glazing U-Factor		Door ⁹ U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall ¹² Above Grade	Wall● int ⁴ Below Grade	Wall● ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical	Overhead ¹¹								
I.	10%	0.40	0.58	0.20	R-38	R-30	R-21 Int ⁷	R-21	R-12	R-30	R-10
II.*	15%	0.40	0.58	0.20	R-38	R-30	R-19 +R-5 ⁸	R-21	R-12	R-30	R-10
III.	17%	0.37	0.58	0.20	R-38	R-30	R-19 +R-5 ⁸	R-21	R-12	R-30	R-10
IV.	Unlimited Group R-3 Occupancy only	0.35	0.58	0.20	R-38	R-30	R-21 Int ⁷	R-21	R-12	R-30	R-10

* Reference Case

0. Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.
1. Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 13%, it shall comply with all of the requirements of the 15% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
2. Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.
3. Requirement applicable only to single rafter or joist vaulted ceilings.
4. Below grade walls shall be insulated either on the exterior to a minimum level of R-10, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
5. Floors over crawl spaces or exposed to ambient air conditions.
6. Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
7. Int. denotes standard framing 16 inches on center with headers insulated with a minimum of R-5 insulation.
8. This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.
9. Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.
10. Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.40 or less is not included in glazing area limitations.
11. Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.
12. Log and solid timber walls with a minimum average thickness of 3.5" are exempt from this insulation requirement.

WAC 51-11-0626 Table 6-2--Reserved.

((TABLE 6-2
**PRESCRIPTIVE REQUIREMENTS* FOR GROUP R OCCUPANCY
 CLIMATE ZONE 1 • HEATING BY OTHER FUELS**

Option	HVAC ⁹ Equip. Effic:	Glazing Area ¹¹ : % of Floor	Glazing U-Factor		Door ¹⁰ U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall Above Grade	Wall ⁴ int ¹ Below Grade	Wall ⁴ ext ¹ Below Grade	Floor ⁷	Slab ⁶ on Grade
			Vertical	Overhead ¹²								
I.	Med.	10%	0.70	0.68	0.40	R-30	R-30	R-15	R-15	R-10	R-19	R-10
II.	Med.	12%	0.65	0.68	0.40	R-30	R-30	R-15	R-15	R-10	R-19	R-10
III.	High	21%	0.75	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
IV. ²	Med.	21%	0.65	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
V.	Low	21%	0.60	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
VI. ⁷	Med.	25%	0.45 ⁷	0.68	0.40	R-38	R-30	R-19	R-19	R-10	R-25	R-10
VII. ⁷	Med.	30%	0.40 ⁷	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-25	R-10
VIII.	Med.	unlimited	0.25	0.40	0.40	R-30	R-30	R-19	R-19	R-10	R-25	R-10

* Reference Case

** Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.

1. Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 10%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
2. Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.
3. Requirement applicable only to single rafter or joist vaulted ceilings.
4. Below grade walls shall be insulated either on the exterior to a minimum level of R-10, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
5. Floors over crawl spaces or exposed to ambient air conditions.
6. Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
7. The following options shall be applicable to buildings less than three stories: 0.50 maximum for glazing areas of 25% or less; 0.45 maximum for glazing areas of 30% or less.
8. Reserved.
9. Minimum HVAC Equipment efficiency requirement. 'Low' denotes an AFUE of 0.74. 'Med.' denotes an AFUE of 0.78. 'High' denotes an AFUE of 0.88. Minimum HVAC Equipment efficiency requirement for heat pumps. 'Low' denotes an HSPF of 6.35. 'Med' denotes an HSPF of 6.8. 'High' an HSPF of 7.7. Water and ground source heat pumps shall be considered as medium efficiency and have a minimum COP as required in Table 5-7.
10. Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.
11. Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U= 0.040 or less is not included in glazing area limitations.
12. Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.)

WAC 51-11-0627 Table 6-3--Reserved.

((TABLE 6-3
 PRESCRIPTIVE REQUIREMENTS^{1, **} FOR GROUP R OCCUPANCY
 CLIMATE ZONE 2 • HEATING BY ELECTRIC RESISTANCE

Option	Glazing Area ^{††} : % of Floor	Glazing U-Factor		Door ^{†††} U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall Above Grade	Wall [•] int ⁴ Below Grade	Wall [•] ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
		Vertical [†]	Overhead ^{†‡}								
I.	10%	0.38	0.58	0.20	R-38	R-30	R-21	R-21	R-12	R-30	R-10
II.	12%	0.40	0.58	0.20	R-38	R-30	R-19+R-5 ⁹	R-21	R-12	R-25	R-10
III. [±]	15%	0.40	0.58	0.20	R-38	R-30	R-19+R-5 ⁹	R-21	R-12	R-30	R-10
IV.	18%	0.38	0.58	0.20	R-38	R-30	R-19+R-5 ⁹	R-21	R-12	R-30	R-10
V.	21%	0.35	0.58	0.20	R-38Adv	R-38	R-19+R-5 ⁹	R-21	R-12	R-30	R-10
VI. ⁷	25%	0.30 ⁷	0.58	0.20	R-49Adv	R-38	R-19+R-5 ⁹	R-21	R-12	R-30	R-10
VII. ⁷	30%	0.28 ⁷	0.58	0.20	R-60Adv	R-38	R-21+R-7.5 ⁹	R-21	R-12	R-30	R-10

- * Reference Case
- ** Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.
- † Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
- ‡ Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.
- § Requirement applicable only to single rafter or joist vaulted ceilings.
- ¶ Below grade walls shall be insulated either on the exterior to a minimum level of R-12, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
- Floors over crawl spaces or exposed to ambient air conditions.
- Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
- 7 The following options shall be applicable to buildings less than three stories: 0.33 maximum for glazing areas of 25% or less; 0.31 maximum for glazing areas of 30% or less.
- 8 This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.
- 9 This wall insulation requirement denotes R-21 wall cavity insulation plus R-7.5 foam sheathing.
- 10 Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.
- 11 Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.040 or less is not included in glazing area limitations.
- 12 Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.)

WAC 51-11-0628 Table 6-4--Reserved.

((TABLE 6-4
 PRESCRIPTIVE REQUIREMENTS^{1, **} FOR GROUP R OCCUPANCY
 CLIMATE ZONE 2 • HEATING BY OTHER FUELS

Option	HVAC ⁹ Equip. Effic.	Glazing Area ^{††} : % of Floor	Glazing U-Factor		Door ^{†††} U-Factor	Ceiling ²	Vaulted Ceiling ³	Wall Above Grade	Wall [•] int ⁴ Below Grade	Wall [•] ext ⁴ Below Grade	Floor ⁵	Slab ⁶ on Grade
			Vertical	Overhead ^{†‡}								
I.	Med.	10%	0.70	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10
II.	Med.	12%	0.65	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10

III:	High	17%	0.65	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10
IV.*	Med.	17%	0.60	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
V:	Low	17%	0.50	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VI:	Med.	24%	0.50	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VII. ⁷	Med.	25%	0.40 ⁷	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VIII. ⁷	Med.	30%	0.40 ⁷	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
IX:	Med.	unlimited	0.25	0.40	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10

- * Reference Case
- ** Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.
- 1 Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.
- 2 Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.
- 3 Requirement applicable only to single rafter or joist vaulted ceilings.
- 4 Below grade walls shall be insulated either on the exterior to a minimum level of R-12, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.
- 5 Floors over crawl spaces or exposed to ambient air conditions.
- 6 Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
- 7 The following options shall be applicable to buildings less than three stories: 0.45 maximum for glazing areas of 25% or less; 0.40 maximum for glazing areas of 30% or less.
- 8 Reserved.
- 9 Minimum HVAC Equipment efficiency requirement. 'Low' denotes an AFUE of 0.74. 'Med.' denotes an AFUE of 0.78. 'High' denotes an AFUE of 0.88. Minimum HVAC Equipment efficiency requirement for heat pumps. 'Low' denotes an HSPF of 6.35. 'Med' denotes an HSPF of 6.8. 'High' an HSPF of 7.7. Water and ground source heat pumps shall be considered as medium efficiency and have a minimum COP as required in Table 5-7.
- 10 Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.
- 11 Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.040 or less is not included in glazing area limitations.
- 12 Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.))

AMENDATORY SECTION (Amending WSR 98-03-003, filed 1/8/98, effective 7/1/98)

WAC 51-11-0629 Table 6-5--Reserved.

((TABLE 6-5
LOG HOMES PRESCRIPTIVE REQUIREMENTS[†]
HEATING BY ELECTRIC RESISTANCE

Option	Average ² Log Thickness	Glazing Area ² : % of Floor	Glazing U-Factor		Door ² U-Factor	Ceiling ²	Vaulted ² Ceiling	Floor ²	Slab ² on Grade
			Vertical	Overhead ¹⁰					
Climate Zone 1									
I. ⁷	5.5"	15%	0.31	0.58	0.14	R-60 Adv	R-38	R-38	R-10
II. ⁷	7.5"	15%	0.40	0.58	0.20	R-60 Adv	R-38	R-30	R-10
III.*	9.6"	15%	0.40	0.58	0.20	R-38	R-30	R-30	R-10
Climate Zone 2									
IV. ⁷	6.7"	15%	0.31	0.58	0.14	R-60 Adv	R-38	R-38	R-10
V. ⁷	8.7"	15%	0.40	0.58	0.14	R-60 Adv	R-38	R-38	R-10
VI. ⁷	9.8"	15%	0.40	0.58	0.20	R-60 Adv	R-38	R-30	R-10
VII. ⁷	10.5"	15%	0.40	0.58	0.20	R-49 Adv	R-38	R-30	R-10
VIII.*	13.5"	15%	0.40	0.58	0.20	R-38	R-30	R-30	R-10

* Reference Case

† For Group R Occupancy use Table 6-5 for only the portion of floor area using log/solid timber walls. Use Tables 6-1 to 6-4 for all other

portions of the floor area. Minimum requirements are for each option listed. Interpolations between options is not permitted. Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.

2 Required minimum average log thickness:

3 'Adv' denotes Advanced Framing. Requirement applies to all ceilings except single rafter joist vaulted ceilings:

4 Requirement applicable only to single rafter joist vaulted ceilings:

5 Floors over crawl spaces or exposed to ambient air conditions:

6 Required slab perimeter insulation shall be water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications:

7 These options shall be applicable to buildings less than three stories:

8 Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C or 10-6D:

9 Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of $U=0.040$ or less is not included in glazing area limitations:

10 Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.))

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-0630 Table 6-6--Reserved.

((TABLE 6-6
LOG HOMES PRESCRIPTIVE REQUIREMENTS^{†,‡,§}
HEATING BY OTHER FUELS

Option	HVAC [§] Equip. Effic.	Glazing Area ^{†,‡} % of Floor	Glazing U-Factor		Door ^{††} U- Factor	Ceiling [‡]	Vaulted Ceiling [‡]	Wall ^{††} Above Grade	Wall [§] int [†] Below Grade	Wall [§] ext [†] Below Grade	Floor [‡]	Slab [§] on Grade
			Vert- ical	Over- head ^{†‡}								
Climate Zone 1												
I:	Med.	10%	0.70	0.68	0.40	R-30	R-30	R-15	R-15	R-10	R-19	R-10
II:	Med.	12%	0.65	0.68	0.40	R-30	R-30	R-15	R-15	R-10	R-19	R-10
III:	High	21%	0.75	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
IV, [‡]	Med.	21%	0.65	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
V:	Low	21%	0.60	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-19	R-10
VI, [‡]	Med.	25%	0.45 [‡]	0.68	0.40	R-38	R-30	R-19	R-19	R-10	R-25	R-10
VII, [‡]	Med.	30%	0.40 [‡]	0.68	0.40	R-30	R-30	R-19	R-19	R-10	R-25	R-10
VIII:	Med.	unlimited	0.25	0.40	0.40	R-30	R-30	R-19	R-19	R-10	R-25	R-10
Climate Zone 2												
I:	Med.	10%	0.70	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10
II:	Med.	12%	0.65	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10
III:	High	17%	0.65	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-25	R-10
IV, [‡]	Med.	17%	0.60	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
V:	Low	17%	0.50	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VI:	Med.	21%	0.50	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VII:	Med.	25%	0.40 [‡]	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VIII:	Med.	30%	0.40 [‡]	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
IX:	Med.	unlimited	0.25	0.40	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10

* Reference Case

** Nominal R-values are for wood frame assemblies only or assemblies built in accordance with Section 601.1.

† Minimum requirements for each option listed. For example, if a proposed design has a glazing ratio to the conditioned floor area of 19%, it shall comply with all of the requirements of the 21% glazing option (or higher). Proposed designs which cannot meet the specific requirements of a listed option above may calculate compliance by Chapters 4 or 5 of this Code.

‡ Requirement applies to all ceilings except single rafter or joist vaulted ceilings. 'Adv' denotes Advanced Framed Ceiling.

†† Requirement applicable only to single rafter or joist vaulted ceilings:

‡‡ Below grade walls shall be insulated either on the exterior to a minimum level of R-10, or on the interior to the same level as walls above grade. Exterior insulation installed on below grade walls shall be a water resistant material, manufactured for its intended use, and installed according to the manufacturer's specifications. See Section 602.2.

§ Floors over crawl spaces or exposed to ambient air conditions:

- 6 Required slab perimeter insulation shall be a water resistant material, manufactured for its intended use, and installed according to manufacturer's specifications. See Section 602.4.
- 7 The following options shall be applicable to buildings less than three stories: 0.50 maximum for glazing areas of 25% or less; 0.45 maximum for glazing areas of 30% or less.
- 8 The following options shall be applicable to buildings less than three stories: 0.45 maximum for glazing areas of 25% or less; 0.40 maximum for glazing areas of 30% or less.
- 9 Minimum HVAC Equipment efficiency requirement. 'Low' denotes an AFUE of 0.74. 'Med.' denotes an AFUE of 0.78. 'High' denotes an AFUE of 0.88. Minimum HVAC Equipment efficiency requirement for heat pumps. 'Low' denotes an HSPF of 6.35. 'Med' denotes an HSPF of 6.8. 'High' an HSPF of 7.7. Water and ground source heat pumps shall be considered as medium efficiency and have a minimum COP as required in Table 5-7.
- 10 Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C.
- 11 Log and solid timber walls with a minimum average thickness of 3.5" are exempt from this insulation requirement.
- 12 Where a maximum glazing area is listed, the total glazing area (combined vertical plus overhead) as a percent of gross conditioned floor area shall be less than or equal to that value. Overhead glazing with U-factor of U=0.040 or less is not included in glazing area limitations.
- 13 Overhead glazing shall have U-factors determined in accordance with NFRC 100 or as specified in Section 502.1.5.))

AMENDATORY SECTION (Amending WSR 95-01-126, filed 12/21/94, effective 6/30/95)

WAC 51-11-0900 Section 0900--Prescriptive heating system sizing. When using the prescriptive approach in Chapter 6, if approved by the building official, design heat load calculations are not required to show compliance to this Code if the heating system installed is equal to or less than the following:

Climate Zone 1	<u>20 Btu/h•ft²</u>
((Electric Resistance	21 Btu/h•ft ²
Electric Resistance (Forced Air)	24 Btu/h•ft ²
Other Fuels (Forced Air)	27 Btu/h•ft ²))
Climate Zone 2	<u>25 Btu/h•ft²</u>
((Electric Resistance	29 Btu/h•ft ²
Electric Resistance (Forced Air)	32 Btu/h•ft ²
Other Fuels (Forced Air)	39 Btu/h•ft ²))

Example: A ((±500)) 2000 ft² house in Zone ((±)) 2, heated with gas, would not have to submit a design heat load if the proposed furnace is ((40,500)) 50,000 Btu or less.

$$((1500 \times 27 = 40,500)) \quad 2000 \times 25 = 50,000$$

Disclaimer: All heating systems shall be designed and installed in accordance with Uniform Building Code Section 310.11.

WAC 51-11-1006 Section 1006 Default U-factors for glazing and doors.

1006.1 Glazing and Doors without NFRC Certification: Glazing and doors that do not have NFRC certification shall be assigned the following U-factors:

**TABLE 10-6
Other than Group R Occupancy: DEFAULT U-FACTORS FOR VERTICAL GLAZING, OVERHEAD GLAZING AND OPAQUE DOORS**

Vertical Glazing		
	U-Factor	
	Any Frame	Vinyl/Wood Frame
Single	1.45	1.45
Double	0.90	0.75
1/2 Inch Air, Fixed	0.75	0.60
1/2 Inch Air, Low-e ^(0.40) , Fixed	0.60	0.50
1/2 Inch Argon, Low-e ^(0.10) , Fixed	0.50	0.40

Overhead Glazing		
	U-Factor	
	Any Frame	Vinyl/Wood Frame
Single	2.15	2.15
Double	1.45	1.00
Low-e ^(0.40) or Argon	1.40	0.95
Low-e ^(0.40) + Argon	1.30	0.85
Low-e ^(0.20) Air	1.30	0.90
Low-e ^(0.20) + Argon	1.25	0.80
Triple	1.25	0.80

Opaque Doors	
	U-Factor
Uninsulated Metal	1.20
Insulated Metal (Including Fire Door and Smoke Vent)	0.60
Wood	0.50

Notes:

- Where a gap width is listed (i.e.: 1/2 inch), that is the minimum allowed.
- Where a low-emissivity emittance is listed (i.e.: 0.40, 0.20, 0.10), that is the maximum allowed.
- Where a gas other than air is listed (i.e.: Argon), the gas fill shall be a minimum of 90%.
- Where an operator type is listed (i.e.: Fixed), the default is only allowed for that operator type.
- Where a frame type is listed (i.e.: Wood/vinyl), the default is only allowed for that frame type. Wood/vinyl frame includes reinforced vinyl and aluminum-clad wood.

TABLE 10-6A
Group R Occupancy: DEFAULT U-FACTORS FOR VERTICAL GLAZING

Description ^{1,2,3,4}		Frame Type ^{5,6}			
		Aluminum	Aluminum Thermal Break ⁷	Wood/Vinyl	
Windows	Single	1.20	1.20	1.20	
	Double, < 1/2"	Clear	0.92	0.75	0.63
		Clear+ Argon	0.87	0.71	0.60
		Low-e	0.85	0.69	0.58
		Low-e+Argon	0.79	0.62	0.53
	Double, ≥ 1/2"	Clear	0.86	0.69	0.58
		Clear+ Argon	0.83	0.67	0.55
		Low-e	0.78	0.61	0.51
		Low-e+Argon	0.75	0.58	0.48
	Triple,	Clear	0.70	0.53	0.43
		Clear+ Argon	0.69	0.52	0.41
		Low-e	0.67	0.49	0.40
		Low-e+Argon	0.63	0.47	0.37
Garden Windows	Single	2.60	n.a.	2.31	
	Double	Clear	1.81	n.a.	1.61
		Clear+ Argon	1.76	n.a.	1.56
		Low-e	1.73	n.a.	1.54
		Low-e+Argon	1.64	n.a.	1.47

- 1 <1/2"= a minimum dead air space of less than 0.5 inches between the panes of glass.
 ≥ 1/2"= a minimum dead air space of 0.5 inches or greater between the panes of glass.
 Where no gap width is listed, the minimum gap width is 1/4".
- 2 Any low-e (emissivity) coating (0.1, 0.2 or 0.4).
- 3 U-factors listed for argon shall consist of sealed, gas-filled insulated units for argon, CO2, SF6, argon/SF6 mixtures and Krypton.
- 4 "Glass block" assemblies may use a U-factor of 0.51.
- 5 Insulated fiberglass framed products shall use wood/vinyl U-factors.
- 6 Aluminum clad wood windows shall use the U-factors listed for wood/vinyl windows.
- 7 Aluminum Thermal Break= An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
 - a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/ft²/°F;
 - b) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and,
 - c) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in a) and b) above.

TABLE 10-6B¹
Group R Occupancy: ((DEFAULT U-FACTORS)) SMALL BUSINESS COMPLIANCE TABLE FOR
VERTICAL GLAZING
((FOR SMALL BUSINESSES))

DESCRIPTION ^{1,2,3,4,(5),(6)}	FRAME TYPE ^{7,8}			
	ALUMINUM	ALUM. THERMAL BREAK ⁹	WOOD/VINYL	ALUM. CLAD WOOD/REINFORCED VINYL ¹⁰
Double, Clear 1/4"	0.82	0.66	0.56	0.59
Double, Clear 1/4"+ argon	0.77	0.63	0.53	0.56
Double, Low-e4 1/4"	0.76	0.61	0.52	0.54
Double, Low-e2 1/4"	0.73	0.58	0.49	0.51
Double, Low-e1 1/4"	0.70	0.55	0.47	0.49
Double, Low-e4 1/4"+ argon	0.70	0.55	0.47	0.49
Double, Low-e2 1/4"+ argon	0.66	0.52	0.43	0.46
Double, Low-e1 1/4"+ argon	0.64	0.50	0.41	0.43
Double, Clear 3/8"	0.78	0.63	0.54	0.57
Double, Clear 3/8"+ argon	0.75	0.60	0.51	0.54
Double, Low-e4 3/8"	0.72	0.57	0.48	0.51
Double, Low-e2 3/8"	0.69	0.54	0.45	0.48
Double, Low-e1 3/8"	0.66	0.51	0.43	0.46
Double, Low-e4 3/8"+ argon	0.68	0.53	0.44	0.47
Double, Low-e2 3/8"+ argon	0.63	0.49	0.41	0.44
Double, Low-e1 3/8"+ argon	0.61	0.47	0.39	0.41
Double, Clear 1/2"	0.75	0.60	0.50	0.54
Double, Clear 1/2"+ argon	0.72	0.58	0.48	0.51
Double, Low-e4 1/2"	0.68	0.53	0.44	0.47
Double, Low-e2 1/2"	0.64	0.50	((0.41)) 0.40	0.44
Double, Low-e1 1/2"	0.61	0.47	((0.39)) 0.35	0.42
Double, Low-e4 1/2"+ argon	0.65	0.50	0.42	0.44
Double, Low-e2 1/2"+ argon	0.60	0.46	0.37	0.40
Double, Low-e1 1/2"+ argon	0.58	0.43	0.35	0.38
Triple, Clear 1/4"	0.66	0.52	0.42	0.44
Triple, Clear 1/4"+ argon	0.63	0.49	0.39	0.42
Triple, Low-e4 1/4"	0.64	0.50	0.40	0.40
Triple, Low-e2 1/4"	0.62	0.48	0.39	0.41
Triple, Low-e1 1/4"	0.61	0.47	0.38	0.40
Triple, Low-e4 1/4"+ argon	0.60	0.46	0.37	0.39
Triple, Low-e2 1/4"+ argon	0.58	0.43	0.34	0.37
Triple, Low-e1 1/4" + argon	0.57	0.42	0.34	0.36
Triple, Clear 1/2"	0.61	0.46	0.37	0.40
Triple, Clear 1/2"+ argon	0.59	0.45	0.36	0.38
Triple, Low-e4 1/2"	0.58	0.43	0.35	0.37
Triple, Low-e2 1/2"	0.55	0.41	0.32	0.35
Triple, Low-e1 1/2"	0.54	0.39	0.31	0.33
Triple, Low-e4 1/2"+ argon	0.55	0.41	0.32	0.35
Triple, Low-e2 1/2"+ argon	0.52	0.38	0.30	0.32
Triple, Low-e1 1/2"+ argon	0.51	0.37	0.29	0.31

Footnotes to Table 10-6B

- 1 Subtract 0.02 from the listed default U-factor for non-aluminum spacer. Acceptable spacer materials may include but is not limited to fiberglass, wood and butyl or other material with an equivalent thermal performance.
- 2 1/4"= a minimum dead air space of 0.25 inches between the panes of glass.
3/8"= a minimum dead air space of 0.375 inches between the panes of glass.
1/2"= a minimum dead air space of 0.5 inches between the panes of glass.
Product with air spaces different than those listed above shall use the value for the next smaller air space; i.e. 3/4 inch= 1/2 inch U-factors, 7/16 inch= 3/8 inch U-factors, 5/16 inch= 1/4 inch U-factors.
- 3 Low-e4 (emissivity) shall be 0.4 or less.
Low-e2 (emissivity) shall be 0.2 or less.
Low-e1 (emissivity) shall be 0.1 or less.
- 4 U-factors listed for argon shall consist of sealed, gas-filled insulated units for argon, CO2, SF6, and argon/SF6 mixtures. The following conversion factor shall apply to Krypton gas-filled units: 1/4" or greater with krypton is equivalent to 1/2" argon.
- 5 ~~((Dividers placed between glazing. The U-factor listed shall be used where the divider has a minimum gap of 1/8 inch between the divider and lite of each inside glass surface. Add 0.03 to the listed U-factor for True Divided Lite windows.))~~ Reserved.
- 6 "Glass block" assemblies may use a U-factor of 0.51.
- 7 Insulated fiberglass framed products shall use wood/vinyl U-factors.
- 8 Subtract 0.02 from the listed default values for solariums.
- 9 Aluminum Thermal Break= An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
 - a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h/ft²/F°;
 - b) The thermal break material must produce a gap in the frame material of not less than 0.210 inches; and,
 - c) All metal framing members of the products exposed to interior and exterior air shall incorporate a thermal break meeting the criteria in a) and b) above.
- 10 Aluminum clad wood windows shall use the U-factors listed for Aluminum Clad Wood/Reinforced Vinyl windows. Vinyl clad wood window shall use the U-factors listed for Wood/Vinyl windows. Any vinyl frame window with metal reinforcement in more than one rail shall use the U-factors listed for Aluminum Clad Wood/Reinforced Vinyl window.

TABLE 10-6C
Group R Occupancy: DEFAULT U-FACTORS FOR DOORS

Door Type	No Glazing	Single Glazing	Double Glazing with 1/4 in. Airspace	Double Glazing with 1/2 in. Airspace	Double Glazing with e=0.10, 1/2 in. Argon
SWINGING DOORS (Rough opening - 38 in. x 82 in.)					
<i>Slab Doors</i>					
Wood slab in wood frame ^a	0.46				
6% glazing (22 in. x 8 in. lite)	-	0.48	0.47	0.46	0.44
25% glazing (22 in. x 36 in. lite)	-	0.58	0.48	0.46	0.42

Door Type	No Glazing	Single Glazing	Double Glazing with 1/4 in. Airspace	Double Glazing with 1/2 in. Airspace	Double Glazing with e=0.10, 1/2 in. Argon
45% glazing (22 in. x 64 in. lite)	-	0.69	0.49	0.46	0.39
More than 50% glazing	Use Table 10-6A				
Insulated steel slab with wood edge in wood frame ^a	0.16				
6% glazing (22 in. x 8 in. lite)	-	0.21	0.20	0.19	0.18
25% glazing (22 in. x 36 in. lite)	-	0.39	0.28	0.26	0.23
45% glazing (22 in. x 64 in. lite)	-	0.58	0.38	0.35	0.26
More than 50% glazing	Use Table 10-6A				
Foam insulated steel slab with metal edge in steel frame ^b	0.37				
6% glazing (22 in. x 8 in. lite)	-	0.44	0.42	0.41	0.39
25% glazing (22 in. x 36 in. lite)	-	0.55	0.50	0.48	0.44
45% glazing (22 in. x 64 in. lite)	-	0.71	0.59	0.56	0.48
More than 50% glazing	Use Table 10-6A				
Cardboard honeycomb slab with metal edge in steel frame ^b	0.61				
<i>Style and Rail Doors</i>					
Sliding glass doors/French doors	Use Table 10-6A				
<i>Site-Assembled Style and Rail Doors</i>					
Aluminum in aluminum frame	-	1.32	0.99	0.93	0.79
Aluminum in aluminum frame with thermal break	-	1.13	0.80	0.74	0.63
REVOLVING DOORS (Rough opening - 82 in. x 84 in.)					
Aluminum in aluminum frame					
Open	-	1.32	-	-	-
Closed	-	0.65	-	-	-
SECTIONAL OVERHEAD DOORS (Nominal - 10 ft x 10 ft)					
Uninsulated steel (nominal U =1.15) ^c	1.15	-	-	-	-
Insulated steel (nominal U =0.11) ^c	0.24	-	-	-	-
Insulated steel with thermal break (nominal U = 0.08) ^c	0.13	-	-	-	-

a. Thermally broken sill (add 0.03 for nonthermally broken sill)

b. Nonthermally broken sill

c. Nominal U-factors are through the center of the insulated panel before consideration of thermal bridges around the edges of the door sections and due to the frame.

TABLE 10-6D

Group R Occupancy: DEFAULT U-FACTORS FOR GLAZED DOORS
See Table 10-6C

TABLE 10-6E

Group R Occupancy: DEFAULT U-FACTORS FOR OVERHEAD GLAZING

Glazing Type	Frame Type			
	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum-Clad Wood or Vinyl	Wood or Vinyl-Clad Wood/ Vinyl without Reinforcing
Single Glazing glass	U-1.58	U-1.51	U-1.40	U-1.18
	U-1.52	U-1.45	U-1.34	U-1.11
Double Glazing air	U-1.05	U-0.89	U-0.84	U-0.67
	U-1.02	U-0.86	U-0.80	U-0.64
Double Glazing, $e=0.20$ air	U-0.96	U-0.80	U-0.75	U-0.59
	U-0.91	U-0.75	U-0.70	U-0.54
Double Glazing, $e=0.10$ air	U-0.94	U-0.79	U-0.74	U-0.58
	U-0.89	U-0.73	U-0.68	U-0.52
Double Glazing, $e=0.05$ air	U-0.93	U-0.78	U-0.73	U-0.56
	U-0.87	U-0.71	U-0.66	U-0.50
Triple Glazing air	U-0.90	U-0.70	U-0.67	U-0.51
	U-0.87	U-0.69	U-0.64	U-0.48
Triple Glazing, $e=0.20$ air	U-0.86	U-0.68	U-0.63	U-0.47
	U-0.82	U-0.63	U-0.59	U-0.43
Triple Glazing, $e=0.20$ on 2 surfaces air	U-0.82	U-0.64	U-0.60	U-0.44
	U-0.79	U-0.60	U-0.56	U-0.40
Triple Glazing, $e=0.10$ on 2 surfaces air	U-0.81	U-0.62	U-0.58	U-0.42
	U-0.77	U-0.58	U-0.54	U-0.38
Quadruple Glazing, $e=0.10$ on 2 surfaces air	U-0.78	U-0.59	U-0.55	U-0.39
	U-0.74	U-0.56	U-0.52	U-0.36
	U-0.70	U-0.52	U-0.48	U-0.32

1. U-factors are applicable to both glass and plastic, flat and domed units, all spacers and gaps.
2. Emissivities shall be less than or equal to the value specified.
3. Gap fill shall be assumed to be air unless there is a minimum of 90% argon or krypton.
4. Aluminum frame with thermal break is as defined in footnote 9 to Table 10-6B.

AMENDATORY SECTION (Amending WSR 93-21-052, filed 10/18/93, effective 4/1/94)

WAC 51-11-1401 Scope. This section covers the determination of requirements, system and component performance, control requirements and duct construction.

((EXCEPTION: Special applications, including but not limited to hospitals, laboratories, thermally sensitive equipment, and rooms designed to comply with the special construction and fire protection requirements of NFPA 75, "Standard for the Protection of Electronic Computer/Data Processing Equipment" may be exempt from the requirements of this section when approved by the building official. Exemptions shall be specific on a case-by-case basis and allowed only to the extent necessary to accommodate the special applications.))

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-1411 HVAC equipment performance requirements.

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 ((14-3)) 14-1G. If a nationally recognized certification program exists for a product covered in Tables 14-1A through ((14-3)) 14-1G, and it includes provisions for verification and challenge of equipment efficiency ratings, then the product shall be listed in the certification program.

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

1411.2 Rating Conditions: Cooling equipment shall be rated at ARI test conditions and procedures when available. Where no applicable procedures exist, data shall be furnished by the equipment manufacturer.

1411.3 Combination Space and Service Water Heating: For combination space and service water heaters with a principal function of providing space heat, the Combined Annual Efficiency (CAE) may be calculated by using ASHRAE Standard 124-1991. Storage water heaters used in combination space heat and water heat applications shall have either an Energy Factor (EF) or a Combined Annual Efficiency (CAE) of not less than the following:

	Energy Factor (EF)	Combined Annual Efficiency (CAE)
< 50 gallon storage	0.58	0.71

50 to 70 gallon storage	0.57	0.71
> 70 gallon storage	0.55	0.70

1411.4 Packaged Electric Heating and Cooling Equipment: Packaged electric equipment providing both heating and cooling 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.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-1412 Controls.

1412.1 Temperature Controls: Each system shall be provided with at least one temperature control device. Each zone shall be controlled by individual thermostatic controls responding to temperature within the zone. At a minimum, each floor of a building shall be considered as a separate zone.

1412.2 Deadband Controls: When used to control both comfort heating and cooling, zone thermostatic controls shall be capable of a deadband of at least 5 degrees F within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

EXCEPTIONS:

1. Special occupancy, special usage, or code requirements where deadband controls are not appropriate.
2. Buildings complying with Section 1141.4, if in the proposed building energy analysis, heating and cooling thermostat setpoints are set to the same temperature between 70 degrees F and 75 degrees F inclusive, and assumed to be constant throughout the year.
3. Thermostats that require manual changeover between heating and cooling modes.

1412.3 Humidity Controls: If a system is equipped with a means for adding moisture, a humidistat shall be provided.

1412.4 Setback and Shut-Off: 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 non-use or alternate use of the spaces served by the system. The automatic controls shall have a minimum seven-day clock and be capable of being set for seven different day types per week.

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.

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.

EXCEPTIONS:

1. Systems serving areas which require continuous operation.
2. Combustion air intakes.
3. Gravity (nonmotorized) dampers are acceptable in buildings less than 3 stories in height.
4. Gravity (nonmotorized) dampers are acceptable in exhaust and relief outlets in the first story and levels below the first story of buildings three or more stories in height.

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/ft² of damper area at 1.0 in w.g.

(b) Nonmotorized dampers: 20 cfm/ft² of damper area at 1.0 in w.g., except that for nonmotorized dampers smaller than 24 inches in either dimension: 40 cfm/ft² of damper area at 1.0 in w.g.

Drawings shall indicate compliance with this section.

1412.4.2 Optimum Start Controls: Heating and cooling systems with design supply air capacities exceeding 10,000 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).

1412.6 Combustion Heating Equipment Controls: Combustion heating equipment with a capacity over 225,000 Btu/h shall have modulating or staged combustion control.

EXCEPTIONS: Boilers.
 Radiant heaters.

1412.7 Balancing: Each air supply outlet or air or water terminal device shall have a means for balancing, including but not limited to, dampers, temperature and pressure test connections and balancing valves.

AMENDATORY SECTION (Amending 93-21-052, filed 10/18/93, effective 4/1/94)

WAC 51-11-1413 ((Air)) Economizers.

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. Air economizers shall be used for RS-29 analysis base case for all systems without exceptions in Sections 1413, 1423, or 1433. 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 45°F dry-bulb/40°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.

EXCEPTION: Water economizers using air-cooled heat rejection equipment may use a 35°F dry-bulb outside air temperature for this calculation. This exception is limited to a maximum of 20 tons per building.

1413.2 ((Control: Air economizers shall be controlled by a control system capable of determining if outside air can meet part or all of the building's cooling loads.)) **Documentation:** Water economizer plans submitted for approval shall include the following information:

1. Maximum outside air conditions for which economizer is sized to provide full cooling.

2. Design cooling load to be provided by economizer at this outside air condition.

3. Heat rejection and terminal equipment performance data including model number, flow rate, capacity, entering and leaving temperature in full economizer cooling mode.

1413.3 Integrated Operation: ((Building Heating Energy:)) 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. ((Controls shall not preclude the economizer operation when mechanical cooling is required simultaneously.))

EXCEPTIONS: ((Economizers on individual, direct expansion, cooling systems with capacities not greater than 75,000 Btu/h may include controls that limit simultaneous operation of the economizer and mechanical cooling for the purpose of preventing ice formation on cooling coils.))

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.

1413.4 **Humidification:** If an air economizer is required on a cooling system for which humidification equipment is to be provided to maintain minimum indoor humidity levels, then the humidifier shall be of the adiabatic type (direct evaporative media or fog atomization type) that cools return air while humidifying outside air while in economizer. If a water economizer or no economizer is provided, the isothermal type of humidifier may be used (steam injection, gas, electric resistance or infrared generator type that uses new energy to boil moisture to be added).

EXCEPTION: Health care facilities where WAC 246-320-525 allows only steam injection humidifiers in ductwork downstream of final filters.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-1423 Economizers. Economizers meeting the requirements of Section 1413 shall be installed on single package unitary fan-cooling units having a supply capacity of greater than 1,900 cfm or a total cooling capacity greater than 54,000 Btu/h including those serving computer server rooms, electronic equipment, radio equipment, telephone switchgear.

The total capacity of all units without economizers shall not exceed 240,000 Btu/h per building, or 10% of its aggregate cooling (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.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-1433 Economizers. Air economizers meeting the requirements of Section 1413 shall ~~((be installed on the following systems:))~~ be provided on all new systems including those serving computer server rooms, electronic equipment, radio equipment, telephone switchgear.

~~((a. Single package unitary fan-cooling units with a supply capacity of greater than 1,900 cfm or a total cooling capacity greater than 54,000 Btu/h.~~

~~b. Other individual fan-cooling units with a supply capacity of greater than 2,800 cfm or a total cooling capacity greater than 84,000 Btu/h.~~

~~The total capacity of all units without economizers shall not exceed 240,000 Btu/h per building, or 10% of its aggregate cooling (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.~~

~~EXCEPTIONS:~~

- ~~1. Systems with air or evaporatively cooled condensers and that either one of the following can be demonstrated to the satisfaction of the enforcing agency:
 - ~~a. Special outside air filtration and treatment, for the reduction and treatment of unusual outdoor contaminants, makes an air economizer infeasible.~~
 - ~~b. The use of outdoor air cooling affects the operation of other systems (such as humidification, dehumidification, and supermarket refrigeration systems) so as to increase the overall building energy consumption.~~~~
- ~~2. Systems for which at least 75 percent of the annual energy used for mechanical cooling is provided from site-recovery or site-solar energy source.~~
- ~~3. A water economizer system, which is capable of cooling supply air by indirect evaporation. Such a system shall be designed and capable of being controlled to provide 100 percent of the expected system cooling load at outside air temperatures of 50 degrees F dry-bulb/45 degrees 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 air temperatures:))~~

EXCEPTIONS: 1. Single package unitary fan-cooling units installed outdoors or in a mechanical room adjacent to outdoors with a total cooling capacity less than 20,000 Btu/h. Other single package unitary fan-cooling units with a total cooling capacity less than 54,000 Btu/h. The total capacity of all such systems without economizers shall not exceed 240,000 Btu/h per building, or

10% of its air economizer capacity, whichever is greater. That portion of the economizer capacity serving Group R occupancy is not included in determining the total capacity of all units without economizers in a building.

2. Water-cooled refrigeration equipment provided with a water economizer meeting the requirements of Section 1413. Water economizer capacity per building shall not exceed 500 tons. This exception shall not be used for RS-29 analysis.

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

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

5. Systems that affect other systems (such as dehumidification and supermarket refrigeration systems) so as to increase the overall building energy consumption. New humidification equipment shall comply with Section 1413.4.

AMENDATORY SECTION (Amending WSR 93-21-052, filed 10/18/93, effective 4/1/94)

WAC 51-11-1437 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 multi-speed motor.
2. Motors used as a component of the equipment meeting the minimum equipment efficiency requirements of Section 1411 and Tables 14-1A ~~((and 14-2))~~ 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.

AMENDATORY SECTION (Amending WSR 98-03-003, filed 1/8/98, effective 7/1/98)

WAC 51-11-1452 (~~((Reserved.))~~) Pool water heaters. Heat pump pool heaters shall have a minimum COP of 4.0 determined in accordance with 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.

AMENDATORY SECTION (Amending WSR 01-03-010, filed 1/5/01, effective 7/1/01)

WAC 51-11-1454 Pool covers. Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90 degrees F shall have a pool cover with a minimum insulation value of R-12.

(TABLE 14-1)
Standard Rating Conditions and Minimum Performance for
Air-Cooled Unitary Air Conditioners, Heat Pumps, Packaged Terminal Air Conditioners,
Warm Air Furnaces, Duct Furnaces and Unit Heaters

Equipment Type & Rating	Category	Sub-category & Rating Conditions	Minimum Rating		Standard
			Steady-State	Seasonal or Part Load	
Air Conditioners and Heat Pumps Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Split Systems Single Package	NA NA	10.0 SEER 9.7 SEER	ARI 210/240 -1989
	≥65,000 and ≤135,000 Btu/h Cooling Capacity	All Unitary Standard Ratings:	8.9 EER 95°F db	8.3 IPLV 80°F db	
	≥135,000 and ≤760,000 Btu/h [†] Cooling Capacity	Air Conditioners Heat Pumps	8.5 EER 8.5 EER	7.5 IPLV 7.5 IPLV	ARI 360 -1986
	≥760,000 Btu/h [†] Cooling Capacity	Air Conditioners Heat Pumps	8.2 EER 8.7 EER	7.5 IPLV 7.5 IPLV	
Packaged Term. Air Conditioners & Heat Pumps Cooling Ratings	All Capacities	Air Conditioners and Heat Pumps Standard/Low Temp[-]	10.0 - (0.16 x Cap/1000) ² EER 95°F	12.2 - (0.20 x Cap/1000) ^{2,3} EER 82°F	ARI 310 -1990
Heat Pump Heating Ratings	≤65,000 Btu/h Cooling Capacity	Split Systems Single Package		6.8 HSPF 6.6 HSPF	ARI 210/240 -1989
	≥65,000 and ≤135,000 Btu/h Cooling Capacity	All Unitary Standard Ratings:	3.0 COP 47°F db/43°F wb	2.0 COP 17°F db/15°F wb	
	≥135,000 Btu/h Cooling Capacity	Standard Ratings[-]	2.9 COP 47°F	2.0 COP 17°F	ARI 365 -1986
Packaged Term. Heat Pumps Heating Ratings	All Capacities	Heat Pumps Standard Ratings[-]	2.9 - (0.026 x Cap/1000) ² COP 47°F db/43°F wb		ARI 380 -1990
Warm Air Furnaces & Combination Furnace/A.C.	<225,000 Btu/h	Gas and Oil Fired Seasonal Ratings[-]	80% E _t ⁴	78% AFUE ⁵	DOE 10 CFR Part 430 AppN
	≥225,000 Btu/h	Gas, Max Rating ⁶ Gas, Min Rating ⁶	80% E _t ⁴ 78% E _t ⁴	NA NA	ANSI Z21.47 -1983
	≥225,000 Btu/h	Oil, Max Rating ⁶ Oil, Min Rating ⁶	81% E _t ⁴ 81% E _t ⁴	NA NA	UL 727 -1986
Warm Air Duct Furnaces and Unit Heaters	All-Size Gas Duct Furnaces	Max Rated Capacity ⁶	78% E _t ⁴	NA	ANSI Z83.9
		Min Rated Capacity ⁶	75% E _t ⁴	NA	-1986
	All-Size Gas Unit Heaters	Max Rated Capacity ⁶	78% E _t ⁴	NA	ANSI Z83.8
		Min Rated Capacity ⁶	74% E _t ⁴	NA	-1985
All-Size Oil Unit Heaters	Max Rated Capacity ⁶	81% E _t ⁴	NA	UL 731	
	Min Rated Capacity ⁶	81% E _t ⁴	NA	-1988	

1. For units that have a heating section, deduct 0.2 from all required EER's and IPLV's.
 2. For multi-capacity equipment the minimum performance shall apply to each step provided. Multi-capacity refers to manufacturer published

rating for more than one capacity mode allowed by the product's controls.

3. Capacity (Cap) means the rated cooling capacity of the product in Btu/h in accordance with the cited ARI standard. If the unit's capacity is less than 7,000 Btu/h, use 7,000 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.
4. These values apply to non-NAECA equipment. See referenced standard for definition of Thermal efficiency (Et), (100% flue losses:))

((TABLE 14-2

**Standard Rating Conditions and Minimum Performance for
Water and Evaporatively Cooled Unitary Air Conditioners, Heat Pumps, Water Source and Ground Source
Heat Pumps, Condensing Units, and Water Chilling Packages**

Equipment Type & Rating	Category	Sub-category & Rating Conditions	Minimum Rating		Standard
			Steady-State	Seasonal or Part Load	
Evaporatively Cooled A/Cs & Heat Pumps Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Standard Conditions ¹ :	9.3 EER	8.5 IPLV	ARI 210/240 +1989
	>65,000 and ≤135,000 Btu/h Cooling Capacity	Outdoor Conditions: 95°F db/75°F wb	10.5 EER	9.7 IPLV	CFR 201 +1986
Water Source Heat Pump Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Standard Conditions ¹ : Entering Water[.]	9.3 EER 85°F cwt ²	10.2 EER 75°F cwt ²	ARI 320 +1986
	>65,000 and ≤135,000 Btu/h Cooling Capacity	Standard Conditions ¹ : Entering Water[.]	10.5 EER 85°F cwt ²	NA	CFR 201 +1986
Ground Water Heat Pump Cooling Ratings	<135,000 Btu/h Cooling Capacity	Standard Conditions ¹ : Entering Water[.]	11.0 EER 70°F cwt ²	11.5 EER 50°F cwt ²	ARI 325 +1985
Water Cooled Unitary Air Conditioners Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Standard Conditions ¹ : Entering Water[.]	9.3 EER 85°F cwt ²	8.3 IPLV 75°F cwt ²	ARI 210/240 +1989
	>65,000 and ≤135,000 Btu/h Cooling Capacity	Standard Conditions ¹ : Entering Water[.]	10.5 EER 85°F cwt ²	NA	CFR 201 +1986
Water/Evap Cooled Air Cond. and Heat Pumps Cooling Ratings	>135,000 Btu/h Cooling Capacity	Standard Conditions ¹ :	9.6 EER	9.0 IPLV	ARI 360 +1986 CFR 201 +1986
Air and Water/Evap Cooled Condensing Units Cooling Ratings ³	>135,000 Btu/h Cooling Capacity	Air Cooled	9.9 EER	11.0 IPLV	ARI 365 +1987
		Water/Evap Cooled	12.9 EER	12.9 IPLV	CFR 201 +1986
Air and Water Cooled Water Chilling Packages Cooling Ratings	<150 Tons	Water Cooled	3.8 COP	3.9 IPLV	ARI 550-90 ARI 590-86pN
	≥150 and <300 Tons		4.2 COP	4.5 IPLV	
	≥300 Tons		5.2 COP ⁴	5.3 IPLV ⁴	CFR 201 +1986
	<150 Tons	Air Cooled with Condenser	2.7 COP	2.8 IPLV	
	≥150 Tons		2.5 COP	2.5 IPLV	
	All Capacities	Air Cooled Condenserless	3.1 COP	3.2 IPLV	
Water & Ground Water Source Heat Pumps Heating Ratings	<135,000 Btu/h Cooling Capacity	Water Source Standard Conditions ¹ :	3.8 COP 70°F cwt ²	NA NA	ARI 320 +1986
		Ground Water Source Standard Conditions ¹ :	3.4 COP 70°F cwt ²	3.0 COP 50°F cwt ²	ARI 325 +1985

1. Standard Indoor Conditions: 80°F dry bulb and 67°F wet bulb.

2. cwt: Entering Water Temperature for water cooled heat pumps and air conditioners.

3. Condensing unit requirements are based on single v-number rating defined in paragraph 5.1.3.2 of ARI Standard 365.

4. These requirements are reduced to 4.7 COP and 4.8 IPLV, where refrigerants with ozone depletion factors of 0.05 or less are used. (No reduction is allowed for standard design systems analyzed under RS-29.)

((TABLE 14-3

**Standard Rating Conditions and Minimum Performance,
Gas- and Oil-Fired Boilers**

Reference	Category	Rating Condition	Minimum Performance
DOE Test Procedure 10 CFR, Part 430 AppN	Gas-Fired <300,000 Btu/h	Seasonal Rating	AFUE 80% ^{1,2}
	Oil-Fired <300,000 Btu/h	Seasonal Rating	AFUE 80% ²
ANSI Z21.13-87 H.I. Htg. Boiler Std. 86 ASME PTC4.1-64 U.L. 795-73	Gas-Fired ≥300,000 Btu/h	1. Max. Rated Capacity ² Steady-State	E _c ⁺ 80%
		2. Min. Rated Capacity ² Steady-State	E _c ⁺ 80%
U.L. 726-75 H.I. Htg. Boiler Std. 86 ASME PTC4.1-64	Oil-Fired ≥300,000 Btu/h	1. Max. Rated Capacity ² Steady-State	E _c ⁺ 83%
		2. Min. Rated Capacity ² Steady-State	E _c ⁺ 83%
H.I. Htg. Boiler Std. 86 ASME PTC4.1-64	Oil-Fired (Residual) ≥300,000 Btu/h	1. Max. Rated Capacity ² Steady-State	E _c ⁺ 83%
		2. Min. Rated Capacity ² Steady-State	E _c ⁺ 83%

1. To be consistent with National Appliance Energy Conservation Act of 1987 (P.L. 100-12).

2. Provided and allowed by the controls.

3. Except for gas-fired steam boilers for which minimum AFUE is 75%.

4. E_c = combustion efficiency, 100% - flue losses. See reference document for detailed information.)

Table 14-1A

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

Equipment Type	Size Category	Sub-Category or Rating Condition	Minimum Efficiency ^b	Test Procedure ^a
Air Conditioners, Air Cooled	< 65,000 Btu/h ^d	Split System	10.0 SEER	ARI 210/240
		Single Package	9.7 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.3 EER ^c	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split System and Single Package	9.7 EER ^c	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split System and Single Package	9.5 EER ^c 9.7 IPLV ^c	
	≥ 760,000 Btu/h	Split System and Single Package	9.2 EER ^c 9.4 IPLV ^c	
Air Conditioners, Water and Evaporatively Cooled	< 65,000 Btu/h	Split System and Single Package	12.1 EER	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	11.5 EER ^c	ARI 340/360
	≥ 135,000 Btu/h and ≤ 240,000 Btu/h	Split System and Single Package	11.0 EER ^c	
	> 240,000 Btu/h	Split System and Single Package	11.0 EER ^c 10.3 IPLV ^c	
Condensing Units, Air Cooled	≥ 135,000 Btu/h		10.1 EER 11.2 IPLV	ARI 365

Condensing Units, Water or Evaporatively Cooled	>135,000 Btu/h	13.1 EER 13.1 IPLV
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^a Reserved.

^b IPLVs are only applicable to equipment with capacity modulation.

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

^d Single-phase air-cooled air-conditioners < 65,000 Btu/h are regulated by NAECA. SEER values are those set by NAECA.

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	10.0 SEER	ARI 210/240
		Single Package	9.7 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split System and Single Package	10.1 EER ^c	ARI 340/360
		Split System and Single Package	9.3 EER ^c	
Water-Source (Cooling Mode)	< 17,000 Btu/h	86°F Entering Water	11.2 EER	ARI/ISO-13256-1
	≥ 17,000 Btu/h and < 65,000 Btu/h	86°F Entering Water	12.0 EER	ARI/ISO-13256-1
	≥ 65,000 Btu/h and < 135,000 Btu/h	86°F Entering Water	12.0 EER	ARI/ISO-13256-1
Groundwater-Source (Cooling Mode)	< 135,000 Btu/h	59°F Entering Water	16.2 EER	ARI/ISO-13256-1
Ground Source (Cooling Mode)	< 135,000 Btu/h	77°F Entering Water	13.4 EER	ARI/ISO-13256-1
Air Cooled (Heating Mode)	< 65,000 Btu/h ^d (Cooling Capacity)	Split System	6.8 HSPF	ARI 210/240
		Single Package	6.6 HSPF	
	≥ 65,000 Btu/h and < 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.2 COP	ARI 340/360
		17°F db/15°F wb Outdoor Air	2.2 COP	
≥ 135,000 Btu/h (Cooling Capacity)	47°F db/43°F wb Outdoor Air	3.1 COP	ARI 340/360	
17°F db/15°F wb Outdoor Air	2.0 COP			
Water-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	68°F Entering Water	4.2 COP	ARI/ISO-13256-1
Groundwater-Source (Heating Mode)	< 135,000 Btu/h (Cooling Capacity)	50°F Entering Water	3.6 COP	ARI/ISO-13256-1

<u>Equipment Type</u>	<u>Size Category</u>	<u>Sub-Category or Rating Condition</u>	<u>Minimum Efficiency^b</u>	<u>Test Procedure^a</u>
<u>Ground Source (Heating Mode)</u>	<u>< 135,000 Btu/h (Cooling Capacity)</u>	<u>32°F Entering Water</u>	<u>3.1 COP</u>	<u>ARI/ISO-13256-1</u>

^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 IPLVs for units with a heating section other than electric resistance heat.

^d Single-phase air-cooled heat pumps < 65,000 Btu/h are regulated by NAECA. SEER and HSPF values are those set by NAECA.

Table 14-1C
Water Chilling Packages, Minimum Efficiency Requirements

<u>Equipment Type</u>	<u>Size Category</u>	<u>Sub-Category or Rating Condition</u>	<u>Minimum Efficiency^b</u>	<u>Test Procedure^a</u>
<u>Air Cooled, With Condenser, Electrically Operated</u>	<u>All Capacities</u>		<u>2.80 COP</u> <u>3.05 IPLV</u>	<u>ARI 550/590</u>
<u>Air Cooled, Without Condenser, Electrically Operated</u>	<u>All Capacities</u>		<u>3.10 COP</u> <u>3.45 IPLV</u>	
<u>Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)</u>	<u>All Capacities</u>		<u>4.20 COP</u> <u>5.05 IPLV</u>	<u>ARI 550/590</u>
<u>Water Cooled, Electrically Operated, Positive Displacement (Rotary Screw and Scroll)</u>	<u>< 150 Tons</u>		<u>4.45 COP</u> <u>5.20 IPLV</u>	<u>ARI 550/590</u>
	<u>≥ 150 Tons and < 300 Tons</u>		<u>4.90 COP</u> <u>5.60 IPLV</u>	
	<u>≥ 300 Tons</u>		<u>5.50 COP</u> <u>6.15 IPLV</u>	
<u>Water Cooled, Electrically Operated, Centrifugal</u>	<u>< 150 Tons</u>		<u>5.00 COP</u> <u>5.25 IPLV</u>	<u>ARI 550/590</u>
	<u>≥ 150 Tons and < 300 Tons</u>		<u>5.55 COP</u> <u>5.90 IPLV</u>	
	<u>≥ 300 Tons</u>		<u>6.10 COP</u> <u>6.40 IPLV</u>	
<u>Air Cooled Absorption Single Effect</u>	<u>All Capacities</u>		<u>0.60 COP</u>	<u>ARI 560</u>
<u>Water Cooled Absorption Single Effect</u>	<u>All Capacities</u>		<u>0.70 COP</u>	
<u>Absorption Double Effect, Indirect-Fired</u>	<u>All Capacities</u>		<u>1.00 COP</u> <u>1.05 IPLV</u>	
<u>Absorption Double Effect, Direct-Fired</u>	<u>All Capacities</u>		<u>1.00 COP</u> <u>1.00 IPLV</u>	

^a Reserved.

^b The chiller equipment requirements do not apply for chillers used in low temperature applications where the design leaving fluid temperature is less than or equal to 40°F.

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

<u>Equipment Type</u>	<u>Size Category (Input)</u>	<u>Sub-Category or Rating Condition</u>	<u>Minimum Efficiency^b</u>	<u>Test Procedure^a</u>
<u>PTAC (Cooling Mode) New Construction</u>	<u>All Capacities</u>	<u>95°F db Outdoor Air</u>	<u>12.5 - (0.213 x Cap/1000)^b EER</u>	<u>ARI 310/380</u>
<u>PTAC (Cooling Mode) Replacements^c</u>	<u>All Capacities</u>	<u>95°F db Outdoor Air</u>	<u>10.9 - (0.213 x Cap/1000)^b EER</u>	
<u>PTHP (Cooling Mode) New Construction</u>	<u>All Capacities</u>	<u>95°F db Outdoor Air</u>	<u>12.3 - (0.213 x Cap/1000)^b EER</u>	
<u>PTHP (Cooling Mode) Replacements^c</u>	<u>All Capacities</u>	<u>95°F db Outdoor Air</u>	<u>10.8 - (0.213 x Cap/1000)^b EER</u>	
<u>PTHP (Heating Mode) New Construction</u>	<u>All Capacities</u>		<u>3.2 - (0.026 x Cap/1000)^b COP</u>	
<u>PTHP (Heating Mode) Replacements^c</u>	<u>All Capacities</u>		<u>2.9 - (0.026 x Cap/1000)^b COP</u>	
<u>Room Air Conditioners, with Louvered Sides</u>	<u>< 6,000 Btu/h</u>		<u>9.7 EER</u>	<u>ANSI/AH AM RAC-1</u>
	<u>≥ 6,000 Btu/h and < 8,000 Btu/h</u>		<u>9.7 EER</u>	
	<u>≥ 8,000 Btu/h and < 14,000 Btu/h</u>		<u>9.8 EER</u>	
	<u>≥ 14,000 Btu/h and < 20,000 Btu/h</u>		<u>9.7 EER</u>	
	<u>≥ 20,000 Btu/h</u>		<u>8.5 EER</u>	
<u>Room Air Conditioners, without Louvered Sides</u>	<u>< 8,000 Btu/h</u>		<u>9.0 EER</u>	
	<u>≥ 8,000 Btu/h and < 20,000 Btu/h</u>		<u>8.5 EER</u>	
	<u>≥ 20,000 Btu/h</u>		<u>8.5 EER</u>	
<u>Room Air Conditioner Heat Pumps with Louvered Sides</u>	<u>< 20,000 Btu/h</u>		<u>9.0 EER</u>	
	<u>≥ 20,000 Btu/h</u>		<u>8.5 EER</u>	
<u>Room Air Conditioner Heat Pumps without Louvered Sides</u>	<u>< 14,000 Btu/h</u>		<u>8.5 EER</u>	
	<u>≥ 14,000 Btu/h</u>		<u>8.0 EER</u>	
<u>Room Air Conditioner, Casement Only</u>	<u>All Capacities</u>		<u>8.7 EER</u>	
<u>Room Air Conditioner, Casement -Slider</u>	<u>All Capacities</u>		<u>9.5 EER</u>	

^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 Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS." Replacement efficiencies apply only to units with existing sleeves less than 16-in. high and less than 42-in. wide.

^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.

Table 14-1E
Warm Air Furnaces and Combination Warm Air Furnaces/Air-Conditioning Units, Warm Air Duct Furnaces and Unit Heaters, Minimum Efficiency Requirements

Equipment Type	Size Category (Input)	Sub-Category or Rating Condition	Minimum Efficiency ^b	Test Procedure ^a
Warm Air Furnace, Gas-Fired	< 225,000 Btu/h (66 kW)		78% AFUE or 80% E _c ^c	DOE 10 CFR Part 430 or ANSI Z21.47
	≥ 225,000 Btu/h (66 kW)	Maximum Capacity ^c Minimum Capacity ^c	80% E _c ^f	ANSI Z21.47
Warm Air Furnace, Oil-Fired	< 225,000 Btu/h (66 kW)		78% AFUE or 80% E _c ^c	DOE 10 CFR Part 430 or UL 727
	≥ 225,000 Btu/h (66 kW)	Maximum Capacity ^b Minimum Capacity ^b	81% E _c ^g —	UL 727
Warm Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity ^b Minimum Capacity ^b	80% E _c ^e —	ANSI Z83.9
Warm Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity ^b Minimum Capacity ^b	80% E _c ^e —	ANSI Z83.8
Warm Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity ^b Minimum Capacity ^b	80% E _c ^e —	UL 731

^a Reserved.

^b Minimum and maximum ratings as provided for and allowed by the unit's controls.

^c Combination units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 65,000 Btu/h [19 kW]) may comply with either rating.

^d E_t = Thermal efficiency. See test procedure for detailed discussion.

^e E_c = Combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

^f E_c = Combustion efficiency. Units must also include an IID, have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

^g E_t = Thermal efficiency. Units must also include an IID, have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

Table 14-1F

Boilers, Gas- and Oil-Fired, Minimum Efficiency Requirements

<u>Equipment Type^f</u>	<u>Size Category</u>	<u>Sub-Category or Rating Condition</u>	<u>Minimum Efficiency^b</u>	<u>Test Procedure</u>
<u>Boilers, Gas-Fired</u>	< 300,000 Btu/h	<u>Hot Water</u>	<u>80% AFUE</u>	<u>DOE 10 CFR Part 430</u>
		<u>Steam</u>	<u>75% AFUE</u>	
	<u>≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h</u>	<u>Maximum Capacity^b</u>	<u>75% E_t</u>	<u>H.I. Htg Boiler Std</u>
		<u>Hot Water</u>	<u>80% E_c</u>	
<u>> 2,500,000 Btu/h^f</u>	<u>Steam</u>	<u>80% E_c</u>		
<u>> 2,500,000 Btu/h^f</u>				
<u>Boilers, Oil-Fired</u>	< 300,000 Btu/h		<u>80% AFUE</u>	<u>DOE 10 CFR Part 430</u>
	<u>≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h</u>	<u>Maximum Capacity^b</u>	<u>78% E_t</u>	<u>H.I. Htg Boiler Std</u>
		<u>Hot Water</u>	<u>83% E_c</u>	
	<u>> 2,500,000 Btu/h^f</u>	<u>Steam</u>	<u>83% E_c</u>	
<u>> 2,500,000 Btu/h^f</u>				
<u>Oil-Fired (Residual)</u>	<u>≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h</u>	<u>Maximum Capacity^b</u>	<u>78% E_t</u>	<u>H.I. Htg Boiler Std</u>
	<u>> 2,500,000 Btu/h^f</u>	<u>Hot Water</u>	<u>83% E_c</u>	
	<u>> 2,500,000 Btu/h^f</u>	<u>Steam</u>	<u>83% E_c</u>	

^a Reserved.

^b Minimum and maximum ratings as provided for and allowed by the unit's controls.

^c E_c = Combustion efficiency (100% less flue losses). See reference document for detailed information.

^d E_t = Thermal efficiency. See reference document for detailed information.

^e Alternate test procedures used at the manufacturer's option are ASME PTC-4.1 for units over 5,000,000 Btu/h input, or ANSI Z21.13 for units greater than or equal to 300,000 Btu/h and less than or equal to 2,500,000 Btu/h input.

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

**Table 14-1G
Performance Requirements for Heat Rejection Equipment**

<u>Equipment Type</u>	<u>Total System Heat Rejection Capacity at Rated Conditions</u>	<u>Sub-Category or Rating Condition</u>	<u>Minimum Efficiency^b</u>	<u>Test Procedure^c</u>
<u>Propeller or Axial Fan Cooling Towers</u>	<u>All</u>	<u>95°F (35°C) Entering Water 85°F (29°C) Leaving Water 75°F (24°C) wb Outdoor Air</u>	<u>≥ 38.2 gpm/hp</u>	<u>CTI ATC-105 and CTI STD-201</u>

<u>Centrifugal Fan Cooling Towers</u>	<u>All</u>	<u>95°F (35°C) Entering Water</u> <u>85°F (29°C) Leaving Water</u> <u>75°F (24°C) wb Outdoor Air</u>	<u>≥ 20.0 gpm/hp</u>	<u>CTI ATC-105 and CTI STD-201</u>
<u>Air Cooled Condensers</u>	<u>All</u>	<u>125°F (52°C) Condensing Temperature</u> <u>R22 Test Fluid</u> <u>190°F (88°C) Entering Gas Temperature</u> <u>15°F (8°C) Subcooling</u> <u>95°F (35°C) Entering Drybulb</u>	<u>≥ 176,000 Btu/h•hp</u>	<u>ARI 460</u>

^a For purposes of this table, cooling tower performance is defined as the maximum flow rating of the tower divided by the fan nameplate rated motor power.

^b 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.

^c Reserved.

TABLE 14-2 RESERVED

TABLE 14-3 RESERVED

**TABLE 14-4
Energy Efficient Electric Motors
Minimum Nominal Full-Load Efficiency**

Synchronous Speed (RPM)	Open Motors			Closed Motors		
	3,600	1,800	1,200	3,600	1,800	1,200
HP	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
1.0	-	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2.0	84.0	84.0	85.5	84.0	84.0	86.5
3.0	84.0	86.5	86.5	85.5	87.5	87.5
5.0	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10.0	88.5	89.5	90.2	89.5	89.5	89.5
15.0	89.5	91.0	90.2	90.2	91.0	90.2
20.0	90.2	91.0	91.0	90.2	91.0	90.2
25.0	91.0	91.7	91.7	91.0	92.4	91.7
30.0	91.0	92.4	92.4	91.0	92.4	91.7
40.0	91.7	93.0	93.0	91.7	93.0	93.0
50.0	92.4	93.0	93.0	92.4	93.0	93.0
60.0	93.0	93.6	93.6	93.0	93.6	93.6
75.0	93.0	94.1	93.6	93.0	94.1	93.6
100.0	93.0	94.1	94.1	93.6	94.5	94.1
125.0	93.6	94.5	94.1	94.5	94.5	94.1
150.0	93.6	95.0	94.5	94.5	95.0	95.0

	Open Motors			Closed Motors		
Synchronous Speed (RPM)	3,600	1,800	1,200	3,600	1,800	1,200
HP	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
200.0	94.5	95.0	94.5	95.0	95.0	95.0

**TABLE 14-5
Duct Insulation**

Duct Type	Duct Location	Insulation R-Value	Other Requirements
Supply, Return	Not within conditioned space: On exterior of building, on roof, in attic, in enclosed ceiling space, in walls, in garage, in crawl spaces	R-7	Approved weather proof barrier
Outside air intake	Within conditioned space	R-7	See Section 1414.2
Supply, Return, Outside air intake	Not within conditioned space: in concrete, in ground	R-5.3	
Supply with supply air temperature <55°F or >105°F	Within conditioned space	R-3.3	

Note: Requirements apply to the duct type listed, whether heated or mechanically cooled. Mechanically cooled ducts requiring insulation shall have a vapor retarder, with a perm rating not greater than 0.5 and all joints sealed.

**TABLE 14-6
Minimum Pipe Insulation (inches)¹**

Fluid Design Operating Temp. Range, °F	Insulation Conductivity		Nominal Pipe Diameter (in.)					
	Conductivity Range Btu • in. / (h • ft ² • °F)	Mean Rating Temp. °F	Runouts ² up to 2	1 and less	>1 to 2	>2 to 4	>4 to 6	>6
Heating systems (Steam, Steam Condensate[,] and Hot water)			Nominal Insulation Thickness					
Above 350	0.32-0.34	250	1.5	2.5	2.5	3.0	3.5	3.5
251-350	0.29-0.31	200	1.5	2.0	2.5	2.5	3.5	3.5
201-250	0.27-0.30	150	1.0	1.5	1.5	2.0	2.0	3.5
141-200	0.25-0.29	125	0.5	1.5	1.5	1.5	1.5	1.5
105-140	0.24-0.28	100	0.5	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems								
105 and Greater	0.24-0.28	100	0.5	1.0	1.0	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine[,] and Refrigerant)								
40-55	0.23-0.27	75	0.5	0.5	0.75	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.0	1.5	1.5	1.5	1.5

1. Alternative Insulation Types. Insulation thicknesses in Table 14-6 are based on insulation with thermal conductivities within the range listed in Table 14-6 for each fluid operating temperature range, rated in accordance with ASTM C 335-84 at the mean temperature listed in the table. For insulation that has a conductivity outside the range shown in Table 14-6 for the applicable fluid operating temperature range at the mean rating temperature shown (when rounded to the nearest 0.01 Btu • in./ (h • ft² • °F)), the minimum thickness shall be determined in accordance with the following equation:

$$T = PR \left[\left(1 + \frac{t}{PR} \right)^{K/k} - 1 \right]$$

Where

- T = Minimum insulation thickness for material with conductivity K, inches.
PR = Pipe actual outside radius, inches[.]
t = Insulation thickness from Table 14-6, inches
K = conductivity of alternate material at the mean rating temperature indicated in Table 14-6 for the applicable fluid temperature range, Btu • in[.]/(h • ft² • °F)
k = the lower value of the conductivity range listed in Table 14-6 for the applicable fluid temperature range, Btu • in[.]/(h • ft² • °F)
2. Runouts to individual terminal units not exceeding 12 ft. in length.