



RULE MAKING ORDER

(RCW 34.05.360)

CR-103 (710/97)

Agency: State Building Code Council

- Permanent Rule
- Emergency Rule
- Expedited Adoption
- Expedited Repeal

(1) Date of Adoption: November 17, 2000

(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Repealed: WAC 51-11 Sections 1201, 1210, 1701, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009

Amended: WAC 51-11 Sections 101, 201, 502, 503, 504, 505, 530, 601, 604, 605, 625, 626, 627, 628, 630, 701, 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1009, 1132, 1313, 1322, 1323, 1331, 1334, 1410, 1411, 1412, 1414, 1415, 1416, 1423, 1433, 1435, 1438, 1439, 1443, 1512, 1513, 1521, 1530, 1531, 1532, 99902, 99903, 99904

Suspended:

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

Other authority:

PERMANENT RULE ONLY (Including EXPEDITED ADOPTION)

Adopted under notice filed as WSR 00-18-017 on Aug 28, 2000 (date).

Describe any changes other than editing from proposed to adopted version: The proposed amendments to the following sections were not adopted: (502.1.5.1, exception 3), 504.5.2, (Tables 5-1, 6-2, 6-4, and 6-6), 602.5, 1312.1, 1412.4.1, (1412.8 and RS-29 Section 3.6.5), (1433 and 1401), (Tables 14-1, 14-2, and 14-3). In addition, the proposal to amend Section 502.1.1 and Table 10-5A (Section 1005) was altered to include the entire table (the roof values were lost in the proposed rule). Also, Table 10-6C (Section 1006) was altered to include a column of values for "Double Glazing with 1/4" Airspace". Also, Section 1411.1 was altered to add the words "nationally recognized" for clarification. Also, Section 1435, exception 1i was altered deleting the second and third sentence for simplicity. Finally, Section 1438 neither option was adopted, instead there was one word change from "frequency" to "speed".

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.

Reasons for this finding:

EXPEDITED REPEAL ONLY

Under Preproposal Statement of Inquiry filed as WSR on (date).

(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:

- |  |  |
|--|--|
| <p><b>Permanent Rules or Expedited Rule Making</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> 31 days after filing</li> <li><input checked="" type="checkbox"/> Other (specify): July 1, 2001*</li> </ul> | <p><b>Emergency Rules</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Immediately</li> <li><input type="checkbox"/> Later (specify)</li> </ul> |
|--|--|

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

NAME (TYPE OR PRINT)

Jim Lewis

SIGNATURE

*Handwritten signature for Jim Lewis*

TITLE

Council Vice Chair

DATE

Jan 3, 2001

CODE REVISER USE ONLY

CODE REVISER'S OFFICE  
STATE OF WASHINGTON  
FILED

JAN 5 2001

TIME 11:26 (AM/PM)

WSR 01-03-010

**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	3	Amended	49	Repealed	13
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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 3	Amended 49	Repealed 13

AMENDATORY SECTION (Amending WSR 98-24-078, filed 12/1/98, effective 7/1/99)

**WAC 51-11-0101 Section 101. Scope and general requirements.**

101.1 Title: Chapters 1 through 10 of this Code shall be known as the "Washington State Residential Energy Code" and may be cited as such; and will be referred to herein as "this Code."

101.2 Purpose and Intent: The purpose of this Code is to provide minimum standards for new or altered buildings and structures or portions thereof to achieve efficient use and conservation of energy.

The purpose of this Code is not to create or otherwise establish or designate any particular class or group of persons who will or should be especially protected or benefitted by the terms of this Code.

It is intended that these provisions provide flexibility to permit the use of innovative approaches and techniques to achieve efficient use and conservation of energy. These provisions are structured to permit compliance with the intent of this Code by any one of the following three paths of design:

1. A systems analysis approach for the entire building and its energy-using sub-systems which may utilize renewable energy sources, Chapter 4.
2. A component performance approach for various building elements and mechanical systems and components, Chapter 5.
3. A prescriptive requirements approach, Chapter 6.

Compliance with any one of these approaches meets the intent of this Code. This Code is not intended to abridge any safety or health requirements required under any other applicable codes or ordinances.

The provisions of this Code do not consider the efficiency of various energy forms as they are delivered to the building envelope. A determination of delivered energy efficiencies in conjunction with this Code will provide the most efficient use of available energy in new building construction.

101.3 Scope: This Code sets forth minimum requirements for the design of new buildings and structures that provide facilities or shelter for residential occupancies by regulating their exterior envelopes and the selection of their HVAC, service water heating systems and equipment for efficient use and conservation of energy.

Buildings shall be designed to comply with the requirements of

either Chapter 4, 5, or 6 of this Code.

101.3.1 Exempt Buildings: Buildings and structures or portions thereof meeting any of the following criteria shall be exempt from the building envelope requirements of sections 502 and 602, but shall comply with all other requirements for building mechanical systems, and service water heating.

101.3.1.1: Buildings and structures or portions thereof whose peak design rate of energy usage is less than three and four tenths (3.4) Btu/h per square foot or one point zero (1.0) watt per square foot of floor area for space conditioning requirements.

101.3.1.2: Buildings and structures or portions thereof which are neither heated according to the definition of heated space in Chapter 2, nor cooled by a nonrenewable energy source, provided that the nonrenewable energy use for space conditioning complies with requirements of section 101.3.1.1.

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

101.3.1.4: The provisions of this code do not apply to the construction, alteration, or repair of temporary worker housing except as provided by rule adopted under chapter 70.114A RCW or chapter 37, Laws of 1998 (SB 6168). "Temporary worker housing" means a place, area, or piece of land where sleeping places or housing sites are provided by an employer for his or her employees or by another person, including a temporary worker housing operator, who is providing such accommodations for employees, for temporary, seasonal occupancy, and includes "labor camps" under RCW 70.54.110.

101.3.2 Application to Existing Buildings: Additions, historic buildings, changes of occupancy or use, and alterations or repairs shall comply with the requirements in the subsections below.

EXCEPTION: The building official may approve designs of alterations or repairs which do not fully conform with all of the requirements of this Code where in the opinion of the building official full compliance is physically impossible and/or economically impractical and:

1. The alteration or repair improves the energy efficiency of the building; or
2. The alteration or repair is energy efficient and is necessary for the health, safety, and welfare of the general public.

In no case, shall building envelope requirements or mechanical system requirements be less than those requirements in effect at the time of the initial construction of the building.

101.3.2.1 Additions to Existing Buildings: Additions to existing buildings or structures may be made to such buildings or structures without making the entire building or structure comply, provided that the new additions shall conform to the provisions of this Code.

EXCEPTION: New additions which do not fully comply with the requirements of this Code and which have a floor area which is less than seven hundred fifty square feet shall be approved provided that improvements are made to the existing occupancy to compensate for any deficiencies in the new addition. Compliance shall be demonstrated by either systems analysis or component performance calculations. The nonconforming addition and upgraded, existing occupancy shall have an energy budget or ~~((heat loss))~~ Target UA which is less than or equal to the unimproved existing building (minus any elements which are no longer part of the building envelope once the addition is added), with the addition designed to comply with this Code.

101.3.2.2 Historic Buildings: The building official may modify the specific requirements of this Code for historic buildings and require in lieu thereof alternate requirements which will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings which have been specifically designated as historically significant by the state or local governing body, or listed in The National Register of Historic Places or which have been determined to be eligible for listing.

101.3.2.3 Change of Occupancy or Use:

Any Other than Group R Occupancy which is converted to Group R Occupancy shall be brought into full compliance with this Code.

101.3.2.4 Alterations and Repairs: All alterations and repairs to buildings or portions thereof originally constructed subject to the requirements of this Code shall conform to the provisions of this Code without exception. For all other existing buildings, initial tenant alterations shall comply with the new construction requirements of this Code. Other alterations and repairs may be made to existing buildings and moved buildings without making the entire building comply with all of the requirements of this Code for new buildings, provided the following requirements are met:

101.3.2.5 Building Envelope: The result of the alterations or repairs both:

1. Improves the energy efficiency of the building, and
2. Complies with the overall average thermal transmittance values of the elements of the exterior building envelope in Table 5-1 of Chapter 5 or the nominal R-values and glazing requirements of the reference case in Tables 6-1 to 6-6.

EXCEPTIONS:

1. Untested storm windows may be installed over existing glazing for an assumed U-factor of 0.90, however, where glass and sash are being replaced in Group R Occupancy, glazing shall comply with the appropriate reference case in Table 6-1 through Table 6-6.

2. Where the structural elements of the altered portions of roof/ceiling, wall or floor are not being replaced, these elements shall be deemed to comply with this Code if all existing framing cavities which are exposed during construction are filled to the full depth with batt insulation or insulation having an equivalent nominal R-value while, for roof/ceilings, maintaining the required space for ventilation. Existing walls and floors without framing cavities need not be insulated. Existing roofs shall be insulated to the requirements of this Code if

- a. The roof is uninsulated or insulation is removed to the level of the sheathing, or
- b. All insulation in the roof/ceiling was previously installed exterior to the sheathing or nonexistent.

101.3.2.6 Building Mechanical Systems: Those parts of systems which are altered or replaced shall comply with section 503 of this Code.

101.3.2.7 Service Water Heating: Those parts of systems which are altered or replaced shall comply with section 504.

101.3.2.8 (~~Reserved~~) Lighting: Alterations shall comply with section 1132.3.

EXCEPTION: Group R-3 occupancy and the dwelling unit portions of Group R-1 occupancy.

101.3.3 Mixed Occupancy: When a building houses more than one occupancy, each portion of the building shall conform to the requirements for the occupancy housed therein. Where approved by the building official, where minor accessory uses do not occupy more than ten percent of the area of any floor of a building, the major use may be considered the building occupancy.

101.4 Amendments by Local Government: Except as provided in RCW 19.27A.020(7), this Code shall be the maximum and minimum energy code for Group R Occupancy in each town, city and county, no later than July 1, 1991.

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

WAC 51-11-0201 ((General definitions.)) Scope. The following definitions shall apply to chapters 1 through 20.

201.1 Application of Terms: For the purposes of this Code, certain abbreviations, terms, phrases, words and their derivatives, shall be as set forth in this chapter. Where terms are not defined, they shall have their ordinary accepted meanings within the context with which they are used. In the event there is a question about the definition of a term, the definitions for terms in the codes enumerated in RCW 19.27.031 and the edition of Webster's dictionary referenced therein shall be considered as the sources for providing ordinarily accepted meanings.

**Addition:** See the Washington State Building Code.

**Advanced framed ceiling:** Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls. (See Standard Framing and Section 1007.2 of this Code.)

**Advanced framed walls:** Studs framed on twenty-four inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall. (See Standard Framing and Section 1005.2 of this Code.)

**AFUE. Annual fuel utilization efficiency:** Unlike steady state conditions, this rating is based on average usage including on and off cycling as set out in the standardized Department of Energy Test Procedures.

**Air conditioning, comfort:** The process of treating air to control simultaneously its temperature, humidity, cleanliness and distribution to meet requirements of the conditioned space.

**ARI:** Air-Conditioning and Refrigeration Institute.

**ASHRAE:** American Society of Heating, Refrigerating and Air

Conditioning Engineers, Inc.

**ASTM:** American Society for Testing and Materials

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

**Below grade walls:** Walls or the portion of walls which are entirely below the finish grade or which extend two feet or less above the finish grade.

~~((Building, existing: See the Washington State Building Code.))~~

**Boiler capacity:** The rate of heat output in Btu/h measured at the boiler outlet, at the design inlet and outlet conditions and rated fuel/energy input.

**Building envelope:** For Group R occupancy, the elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior or to or from spaces exempted by the provisions of Section 101.3.1. For other than Group R occupancy, the elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from semi-heated spaces, or to or from spaces exempted by the provisions of Section 1301.

Building, existing: See the Washington State Building Code.

**Building official:** The official authorized to act in behalf of a jurisdiction code enforcement agency or its authorized representative.

**Building project:** A building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or are within the boundary of a contiguous area under one ownership.

~~((Comfort envelope: The area on a psychrometric chart enclosing all those conditions described in Standard RS-4, Figure No. 1, as being comfortable.))~~

Conditioned floor area: (See Gross conditioned floor area.)

**Conditioned space:** ~~((All spaces which are provided with heated and/or cooled air or which are capable of being maintained at temperatures over fifty degrees F during the heating season, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors.))~~ A cooled space, heated space (fully heated), heated space (semi-heated) or indirectly conditioned space.

**Cooled space:** ~~((Space within a building which is provided with a positive cooling supply.))~~ An enclosed space within a building that is cooled by a cooling system whose sensible capacity  
a. exceeds 5 Btu/(h • ft<sup>2</sup>), or  
b. is capable of maintaining space dry bulb temperature of 90°F or less at design cooling conditions.

**COP - Coefficient of performance:** The ratio of the rate of net heat output (heating mode) or heat removal (cooling mode) to the rate of total on-site energy input to the heat pump, expressed in consistent units and under designated rating conditions. (See

Net Heat Output, Net Heat Removal, Total On-Site Energy Input.)

**Daylighted zone:**

a. Under overhead glazing: the area under overhead glazing whose horizontal dimension, in each direction, is equal to the overhead glazing dimension in that direction plus either the floor to ceiling height or the dimension to a ceiling height opaque partition, or one-half the distance to adjacent overhead or vertical glazing, whichever is least.

b. At vertical glazing: the area adjacent to vertical glazing which receives daylighting from the glazing. For purposes of this definition and unless more detailed daylighting analysis is provided, the daylighting zone depth is assumed to extend into the space a distance of 15 feet or to the nearest ceiling height opaque partition, whichever is less. The daylighting zone width is assumed to be the width of the window plus either two feet on each side (the distance to an opaque partition) or one-half the distance to adjacent overhead or vertical glazing, whichever is least.

**Daylight sensing control (DS):** A device that automatically regulates the power input to electric lighting near the glazing to maintain the desired workplace illumination, thus taking advantage of direct or indirect sunlight.

**Deadband:** The temperature range in which no heating or cooling is used.

~~((Degree day, heating: A unit, based upon temperature difference and time, used in estimating fuel consumption and specifying nominal heating load of a building in winter. For any one day when the mean temperature is less than sixty-five degrees F there exist as many degree days as there are Fahrenheit degrees difference in temperature between the mean temperature for the day and sixty-five degrees F.))~~

**Design cooling conditions:** The cooling outdoor design temperature from the 0.5% column for summer from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE."

**Design heating conditions:** The heating outdoor design temperature from the 0.6% column for winter from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE."

**Door:** ~~((An operable opening area in the shell of a conditioned space, excluding sliding glass doors, which is designed and used as a means of ingress and egress. A door may also include a double door one of which is fixed and one of which is operable.))~~  
All operable opening areas, which are not glazing, in the building envelope including swinging and roll-up doors, fire doors, smoke vents and access hatches.

**Door area:** Total area of door measured using the rough opening and including the door and frame.

**Dwelling unit:** See the Washington State Building Code.

**EER. Energy efficiency ratio:** The ratio of net equipment cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions.

**Economizer, air:** A ducting arrangement and automatic control

system that allows a cooling supply fan system to supply outside air to reduce or eliminate the need for mechanical refrigeration during mild or cold weather.

**Economizer, water:** A system by which the supply air of a cooling system is cooled directly, indirectly or both, by evaporation of water or by other appropriate fluid in order to reduce or eliminate the need for mechanical refrigeration.

**Efficiency, HVAC system:** The ratio of useful energy (at the point of use) to the energy input for a designated time period, expressed in percent.

**Emissivity:** The ability to absorb infrared radiation. A low emissivity implies a higher reflectance of infrared radiation.

**Energy:** The capacity for doing work; taking a number of forms which may be transformed from one into another, such as thermal (heat), mechanical (work), electrical and chemical; in customary units, measured in kilowatt-hours (kWh) or British thermal units (Btu). (See **New energy.**)

**Energy, recovered:** (See **Recovered energy.**)

**Exterior envelope:** (See **Building envelope.**)

**Facade area:** Vertical projected area including nonhorizontal roof area, overhangs, cornices, etc. measured in elevation in a vertical plane parallel to the plane of the building face.

**Floor over unconditioned space:** A floor which separates a conditioned space from an unconditioned space which is buffered from exterior ambient conditions including vented crawl spaces and unconditioned basements or other similar spaces, or exposed to exterior ambient conditions including open parking garages and enclosed garages which are mechanically ventilated.

**F-Factor:** The perimeter heat loss factor expressed in Btu/hr•ft•°F.

**F-Value:** (See **F-Factor.**)

**Garden window:** A multi-sided glazing product that projects beyond the plane of the wall.

**Glazed wall system:** A category of site assembled fenestration products used in the NFRC 100 and NFRC 200 rating procedures that include curtainwalls.

**Glazing:** All areas, including the frames, in the shell of a conditioned space that let in natural light including windows, clerestories, skylights, sliding or swinging glass doors and glass block walls. (~~The daylight opening area in all other doors shall be considered glazing for the purpose of calculating glazing area. The daylight opening area in all other doors is included in the door U-factor and shall not be considered in calculations of glazing U-factors.~~)

**Glazing area:** Total area of the glazing measured using the rough opening, and including the glazing, sash, and frame. (~~For sliding glass doors the glazing area is the rough opening area. For all other doors the glazing area is the daylight opening area.~~) For doors where the daylight opening area is less than 50% of the door area, the glazing area is the daylight opening area. For all other doors, the glazing area is the door area.

**Gross conditioned floor area:** The horizontal projection of that portion of interior space which is contained within exterior walls and which is conditioned directly or indirectly by an energy-using system, and which has an average height of five feet or greater, measured from the exterior faces.

**Gross exterior wall area:** The normal projection of the building envelope wall area bounding interior space which is conditioned by an energy-using system and which separates conditioned space from: Unconditioned space, or semi-heated space, or exterior ambient conditions or earth; includes opaque wall, ~~((window))~~ vertical glazing and door areas. The gross area of walls consists of all opaque wall areas, including foundation walls, between floor spandrels, peripheral edges of floors, ~~((window))~~ vertical glazing areas ~~((including sash,))~~ and door areas, where such surfaces are exposed to exterior ambient conditions and enclose a conditioned space including interstitial areas between two such spaces. (See Below grade wall.)

**Gross floor area:** The sum of the areas of the several floors of the building, including basements, cellars, mezzanine and intermediate floored tiers and penthouses of headroom height, measured from the exterior faces of exterior walls or from the center line of walls separating buildings, but excluding: Covered walkways, open roofed-over areas, porches and similar spaces. Pipe trenches, exterior terraces or steps, chimneys, roof overhangs and similar features.

**Gross roof/ceiling area:** ~~((The sum of the areas of the roof/ceiling assembly, consisting of the total interior surface area of all elements, including skylights, which enclose a conditioned space.))~~ A roof/ceiling assembly shall be considered as all components of the roof/ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed to exterior ambient conditions and encloses a conditioned space. The assembly does not include those components that are separated from a heated and/or cooled space by a vented airspace. The gross area of a roof/ceiling assembly consists of the total interior surface of such assembly, including overhead glazing.

**Guest room:** See the Washington State Building Code.

**Heat:** The form of energy that is transferred by virtue of a temperature difference.

**Heat storage capacity:** The physical property of materials (mass) located inside the building envelope to absorb, store, and release heat.

**Heated space (Fully heated):** ~~((Space within a building which is provided with a positive heating supply. Finished living space within a basement or registers or heating devices designed to supply heat to a basement space shall automatically define that space as heated space. (See Positive Heating Supply.))~~ An enclosed space within a building, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors), which is heated by a heating system whose output capacity is

- a. Capable of maintaining a space dry-bulb temperature of 45°F or greater at design heating conditions; or  
b. 8 Btu/(h • ft<sup>2</sup>) or greater in Climate Zone 1 and 12 Btu/(h • ft<sup>2</sup>) or greater in Climate Zone 2.

**Heated space (Semi-heated):** An enclosed space within a building, including adjacent connected spaces separated by an uninsulated component (e.g., basements, utility rooms, garages, corridors), which is heated by a heating system

- a. whose output capacity is 3 Btu/(h • ft<sup>2</sup>) or greater in Climate Zone 1 and 5 Btu/(h • ft<sup>2</sup>) or greater in Climate Zone 2; and  
b. is not a Heated Space (Fully Heated).

**HSPF. Heating season performance factor:** The total heating output (in Btu) of a heat pump during its normal annual usage period for heating divided by the total (watt hour) electric power input during the same period, as determined by test procedures consistent with the U.S. Department of Energy "Test Procedure for Central Air Conditioners, Including Heat Pumps" published in (~~the December 27, 1979, Federal Register, Vol 44, No. 24, IOCFR. 430~~) Standard RS-30. When specified in Btu per watt hour an HSPF of 6.826 is equivalent to a COP of 2.0.

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

**HVAC:** Heating, ventilating and air conditioning.

**HVAC system components:** HVAC system components provide, in one or more factory-assembled packages, means for chilling and/or heating water with controlled temperature for delivery to terminal units serving the conditioned spaces of the buildings. Types of HVAC system components include, but are not limited to, water chiller packages, reciprocating condensing units and water source (hydronic) heat pumps. (See **HVAC system equipment.**)

**HVAC system efficiency:** (See **Efficiency, HVAC system.**)

**HVAC system equipment:** HVAC system equipment provides, in one (single package) or more (split system) factory-assembled packages, means for air circulation, air cleaning, air cooling with controlled temperature and dehumidification; and optionally, either alone or in combination with a heating plant, the functions of heating and humidifying. The cooling function may be either electrically or heat operated and the refrigerant condenser may be air, water or evaporatively cooled. Where the equipment is provided in more than one package, the separate packages shall be designed by the manufacturer to be used together. The equipment may provide the heating function as a heat pump or by the use of electric elements. (The word "equipment" used without modifying adjective may, in accordance with common industry usage, apply either to HVAC system equipment or HVAC system components.)

(~~illumination: The density of the luminous flux incident on a surface, it is the quotient of the luminous flux by the area of the surface when the latter is uniformly illuminated.~~)

**Indirectly conditioned space:** An enclosed space within a building that is not a heated or cooled space, whose area weighted heat transfer coefficient to heated or cooled spaces exceeds that to the outdoors or to unconditioned spaces; or through which air

from heated or cooled spaces is transferred at a rate exceeding three air changes per hour. Enclosed corridors between conditioned spaces shall be considered as indirectly conditioned space. (See Heated Space, Cooled Space and Unconditioned Space.)

**Infiltration:** The uncontrolled inward air leakage through cracks and interstices in any building element and around windows and doors of a building caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

**Insulation baffle:** A rigid material, resistant to wind driven moisture, the purpose of which is to allow air to flow freely into the attic or crawl space and to prevent insulation from blocking the ventilation of these spaces, or the loss of insulation. Example materials for this purpose are sheet metal, or wax impregnated cardboard.

**Insulation position:**

a. Exterior Insulation Position: a wall having all or nearly all of its mass exposed to the room air with the insulation on the exterior of the mass.

b. Integral Insulation Position: a wall having mass exposed to both room and outside air, with substantially equal amounts of mass on the inside and outside of the insulation layer.

c. Interior Insulation Position: a wall not meeting either of the above definitions; particularly a wall having most of its mass external to the insulation layer.

**IPLV--Integrated part-load value:** A single number figure of merit based on part-load EER or COP expressing part-load efficiency for air conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment as specified in the Air-Conditioning and Refrigeration Institute (ARI) and Cooling Tower Institute (CTI) procedures.

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

**Manual:** Capable of being operated by personal intervention. (See **Automatic.**)

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

**NFPA:** National Fire Protection Association.

**NFRC:** National Fenestration Rating Council.

**Net heat output:** The change in the total heat content of the air entering and leaving the equipment (not including supplementary heat and heat from boilers).

**Net heat removal:** The total difference in heat content of the air entering and leaving the equipment (without heat) or the

difference in total heat content of the water or refrigerant entering and leaving the component.

**New energy:** Energy, other than recovered energy, utilized for the purpose of heating or cooling. (See **energy**.)

**Nominal R-value:** The thermal resistance of insulation as specified by the manufacturer according to recognized trade and engineering standards.

**Nonrenewable energy sources:** All energy sources that are not renewable energy sources including natural gas, oil, coal, wood, liquified petroleum gas, steam, and any utility-supplied electricity.

**Nonresidential:** All buildings and spaces in the Uniform Building Code (UBC) occupancies other than Group R.

**Occupancy:** See the Washington State Building Code.

**Occupancy sensor:** A device that detects occupants within an area, causing any combination of lighting, equipment or appliances to be turned on or shut off.

**Opaque envelope areas:** All exposed areas of a building envelope which enclose conditioned space, except openings for (~~windows, skylights,~~) doors, glazing and building service systems.

**Open blown:** Loose fill insulation pneumatically installed in an unconfined attic space.

**Outdoor air (outside air):** Air taken from the outdoors and, therefore, not previously circulated through (~~the system~~) a building.

**Overhead glazing:** A glazing surface that has a slope of less than 60° from the horizontal plane.

**Packaged terminal air conditioner:** A factory-selected combination of heating and cooling components, assemblies or sections intended to serve a room or zone. (For the complete technical definition, see Standard RS-10.)

~~((Packaged terminal heat pump: A factory-selected combination of heating and cooling components, assemblies or sections intended for application in an individual room or zone. (For the complete technical definition, see Standard RS-21.))~~

**Permeance (perm):** The ability of a material of specified thickness to transmit moisture in terms of amount of moisture transmitted per unit time for a specified area and differential pressure (grains per hour • ft<sup>2</sup> • inches of HG). Permeance may be measured using ASTM E-96-72 or other approved dry cup method as specified in (~~RS-1~~) RS-27.

**Personal wireless service facility:** A Wireless Communication Facility (WCF), including a microcell, which is a facility for the transmission and/or reception of radio frequency signals and which may include antennas, equipment shelter or cabinet, transmission cables, a support structure to achieve the necessary elevation, and reception and/or transmission devices or antennas.

**Pool cover:** A vapor-retardant cover which lies on or at the surface of the pool.

~~((Positive cooling supply: Mechanical cooling deliberately~~

~~supplied to a space, such as through a supply register. Also, mechanical cooling indirectly supplied to a space through uninsulated surfaces of space cooling components, such as evaporator coil cases and cooling distribution systems which are capable of maintaining air temperatures within the space of eighty-five degrees F, or lower, at the exterior design conditions specified in Section 302.1. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this Code.~~

~~**Positive heating supply:** Heat deliberately supplied to a space by design, such as a supply register, radiator or heating element. Also, heat indirectly supplied to a space through uninsulated surfaces of service water heaters and space heating components, such as furnaces, boilers and heating and cooling distributions systems which are capable of maintaining air temperature within the space of fifty degrees F, or higher, at the exterior design conditions specified in Section 302.1. To be considered exempt from inclusion in this definition, such surfaces shall comply with the insulation requirements of this Code.)~~

**Power:** In connection with machines, the time rate of doing work. In connection with the transmission of energy of all types, the rate at which energy is transmitted; in customary units, it is measured in watts (W) or British Thermal Units per hour (Btu/h).

~~((**Public facility rest room:** A rest room used by the transient public on a regular (rather than casual) basis. Examples include rest rooms in service stations, airports, train terminals and convention halls. Rest rooms incorporated with private guest rooms in hotels, motels or dormitories and rest room facilities intended for the use of employees and not usually used by the general public are not considered public facility rest rooms.))~~

**Process energy:** Energy consumed in support of a manufacturing, industrial, or commercial process other than the maintenance of building comfort or amenities for building occupants.

**Radiant slab floor:** A slab floor assembly on grade or below, containing heated pipes, ducts, or electric heating cables that constitute a ((~~radiant slab~~)) floor or portion thereof for ((a)) complete or partial heating of the structure.

**Readily accessible:** See the Washington State Mechanical Code.

**Recooling:** The removal of heat by sensible cooling of the supply air (directly or indirectly) that has been previously heated above the temperature to which the air is to be supplied to the conditioned space for proper control of the temperature of that space.

**Recovered energy:** Energy utilized which would otherwise be wasted (i.e. not contribute to a desired end use) from an energy utilization system.

**Reheat:** The application of sensible heat to supply air that has been previously cooled below the temperature of the conditioned space by either mechanical refrigeration or the introduction of outdoor air to provide cooling.

**Renewable energy sources:** Renewable energy sources of energy (excluding minerals) are derived from: (1) incoming solar

radiation, including but not limited to, natural daylighting and photosynthetic processes; (2) energy sources resulting from wind, waves and tides, lake or pond thermal differences; and (3) energy derived from the internal heat of the earth, including nocturnal thermal exchanges.

**Reset:** Adjustment of the set point of a control instrument to a higher or lower value automatically or manually to conserve energy.

**Roof/ceiling assembly:** (~~(A roof/ceiling assembly shall be considered as all components of the roof/ceiling envelope through which heat flows, thus creating a building transmission heat loss or gain, where such assembly is exposed exterior ambient conditions to and encloses a conditioned space. The gross area of a roof/ceiling assembly consists of the total interior surface of such assembly, including skylights.)~~) (See Gross roof/ceiling area.)

**SEER - Seasonal Energy Efficiency Ratio:** The total cooling output of an air conditioner during its normal annual usage period, in Btu's, divided by the total electric energy input in watt-hours, during the same period, as determined by 10 CFR, Part 430.

**Semi-heated space:** Sub-category of Heated Space. (See Heated Space.)

**Sequence:** A consecutive series of operations.

**Service systems:** All energy-using systems in a building that are operated to provide services for the occupants or processes housed therein, including HVAC, service water heating, illumination, transportation, cooking or food preparation, laundering or similar functions.

**Service water heating:** Supply of hot water for domestic or commercial purposes other than comfort heating.

**Shaded:** Glazed area which is externally protected from direct solar radiation by use of devices permanently affixed to the structure or by an adjacent building, topographical feature, or vegetation.

**Shading coefficient:** The ratio of solar heat gain occurring through nonopaque portions of the glazing, with or without integral shading devices, to the solar heat gain occurring through an equivalent area of unshaded, 1/8 inch thick, clear, double-strength glass.

Note: Heat gains to be compared under the same conditions. See Chapter 28 of Standard RS-27, listed in Chapter 7 of this Code.

**Shall:** Denotes a mandatory code requirement.

**Single family:** One and two family residential dwelling units with no more than two units in a single building.

**Skylight:** (~~(A glazing surface that has a slope of less than sixty degrees from the horizontal plane.)~~) (See Overhead glazing.)

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

**Slab-on-grade, exterior:** Any portion of a slab floor in contact with the ground which is less than or equal to twenty-four inches below the final elevation of the nearest exterior grade.

~~((Slab below grade: Any portion of a slab floor in contact with the ground which is more than twenty-four inches below the final elevation of the nearest exterior grade.))~~

**Small business:** Any business entity (including a sole proprietorship, corporation, partnership, or other legal entity) which is owned and operated independently from all other businesses, which has the purpose of making a profit, and which has fifty or fewer employees, or which has a million dollars or less per year in gross sales, of window products.

**Solar energy source:** Source of natural daylighting and of thermal, chemical or electrical energy derived directly from conversion of incident solar radiation.

**Solar heat gain coefficient (SHGC):** The ratio of the solar heat gain entering the space through the glazing product to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation which is then reradiated, conducted or convected into the space.

**Split system:** Any heat pump or air conditioning unit which is provided in more than one assembly requiring refrigeration piping installed in the field.

**Standard framing:** All framing practices not defined as "intermediate" or "advanced" shall be considered standard. (See Advanced framed ceiling, Advanced framed walls, Intermediate framed wall and Section 1005.2 of this Code.)

**Substantial contact:** A condition where adjacent building materials are placed in a manner that proximal surfaces are contiguous, being installed and supported as to eliminate voids between materials, without compressing or degrading the thermal performance of either product.

**System:** A combination of central or terminal equipment or components and/or controls, accessories, interconnecting means, and terminal devices by which energy is transformed so as to perform a specific function, such as HVAC, service water heating or illumination.

**Tapering:** Installation of a reduced level of ceiling insulation at the eaves, due to reduced clearance.

**Thermal by-pass:** An area where the envelope surrounding the conditioned space is breached, or where an ineffective application compromises the performance of a thermal or infiltration barrier, increasing the structure's energy consumption by exposing finished surfaces to ambient conditions and additional heat transfer.

**Thermal conductance (C):** Time rate of heat flow through a body (frequently per unit area) from one of its bounding surfaces to the other for a unit temperature difference between the two surfaces, under steady conditions (Btu/hr•ft<sup>2</sup>•°F).

**Thermal resistance (R):** The reciprocal of thermal conductance (hr•ft<sup>2</sup>•°F/Btu).

**Thermal transmittance (U):** The coefficient of heat transmission (air to air). It is the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/hr•ft<sup>2</sup>•°F). ~~((The U-factor applies to the fractional combinations of different materials used in series along~~

~~the heat flow path.))~~

**Thermal transmittance, overall ( $U_o$ ):** The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/hr•ft<sup>2</sup>•°F). The  $U_o$ -factor applies to the combined effect of the time rate of heat flows through the various parallel paths, such as (~~(windows,)~~) glazing, doors and opaque construction areas, comprising the gross area of one or more exterior building components, such as walls, floors or roof/ceiling.

**Thermostat:** An automatic control device actuated by temperature and designed to be responsive to temperature.

**Total on-site energy input:** The combination of all the energy inputs to all elements and accessories as included in the equipment components, including but not limited to, compressor(s), compressor sump heater(s), circulating pump(s), purge devices, fan(s), and the HVAC system component control circuit.

**Transmission coefficient:** The ratio of the solar heat gain through a glazing system to that of an unshaded single pane of double strength window glass under the same set of conditions.

**U-factor:** (See thermal transmittance.)

**U-Value:** (See U-factor.)

**Uniform Building Code (UBC):** (~~(The Washington State Uniform Building Code as modified by the Washington State Building Code Council.)~~) (See Washington State Building Code.)

**Uniform Mechanical Code (UMC):** (~~(The Washington State Uniform Mechanical Code as modified by the Washington State Building Code Council.)~~) (See Washington State Mechanical Code.)

**Uniform Plumbing Code (UPC):** (See Washington State Plumbing Code.)

**Unitary cooling and heating equipment:** One or more factory-made assemblies which include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well. Where such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

**Unitary heat pump:** One or more factory-made assemblies which include an indoor conditioning coil, compressor(s) and outdoor coil or refrigerant-to-water heat exchanger, including means to provide both heating and cooling functions. When such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together.

**Vapor retarder:** A layer of low moisture transmissivity material (not more than 1.0 perm dry cup) placed over the warm side (in winter) of insulation, over the exterior of below grade walls, and under floors as ground cover to limit the transport of water and water vapor through exterior walls, ceilings, and floors. Vapor retarding paint, listed for this application, also (~~(complies with this Code)~~) meets this definition.

**Vaulted ceilings:** All ceilings where enclosed joist or rafter space is formed by ceilings applied directly to the underside of roof joists or rafters.

**Ventilation:** The process of supplying or removing air by natural or mechanical means to or from any space. Such air may or

may not have been conditioned.

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

**Vertical glazing:** A glazing surface that has a slope of 60° or greater from the horizontal plane.

**Walls (exterior):** Any member or group of members which defines the exterior boundaries or courts of a building and which have a slope of sixty degrees or greater with the horizontal plane, and separates conditioned from unconditioned space. Band joists between floors are to be considered a part of exterior walls.

**Washington State Building Code:** The building code as modified by the Washington State Building Code Council.

**Washington State Mechanical Code:** The mechanical code as modified by the Washington State Building Code Council.

**Washington State Plumbing Code:** The plumbing code as modified by the Washington State Building Code Council.

**Zone:** A space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device. Each dwelling unit in residential buildings shall be considered a single zone.

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

**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 (~~(from the following table for metal stud walls and roof ceilings:)~~) in Table 10-5A - EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY for metal stud walls and roof/ceilings.

	((Framing		Cavity Insulation		
	Nominal Depth, Inches	Actual Depth, Inches	Nominal R-Value	Effective R-Value	
				Framing 16" o.c.	Framing 24" o.c.
Wall	4	3-1/2	R-11	R-5.5	R-6.6
	4	3-1/2	R-13	R-6.0	R-7.2
	4	3-1/2	R-15	R-6.4	R-7.8
	6	5-1/2	R-19	R-7.1	R-8.6
	6	5-1/2	R-21	R-7.4	R-9.0
	8	7-1/4	R-25	R-7.8	R-9.6
Roof		Insulation is uncompressed	R-11	R-5.5	R-6.1
			R-19	R-7.0	R-9.1
			R-30	R-9.3	R-11.4))

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 m<sup>2</sup>) 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 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 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 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):

- 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 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 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 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: (~~Half-lite and full-lite doors, including fire doors, shall be assigned default U-factors from Table 10-6D.~~) All (~~other~~) 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.

#### 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/ft<sup>2</sup>) 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/ft<sup>2</sup> pressure difference and have a label attached, showing compliance.

AMENDATORY SECTION (Amending WSR 98-24-075, filed 12/1/98, effective 7/1/99)

**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.

~~((EXCEPTIONS:—Special applications, including but not limited to hospitals, laboratories, thermally sensitive equipment, and computer rooms may be exempted from the requirements of this section when approved by the building official.))~~

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 ~~((fifty-six thousand Btu/h or less))~~

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 ~~((the sum of seventy-eight percent plus one percent for every five thousand Btu/h that the space heating equipment output exceeds the design heating load of the dwelling unit))~~ 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:

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): ~~((Each fan system shall be designed to use up to and including 100% of the fan system capacity for cooling with outdoor air automatically whenever its use will result in lower usage of new energy. Activation of economizer cycle shall be controlled by sensing outdoor air enthalpy or outdoor air dry-bulb temperature alone or alternate means approved by the building official.~~

EXCEPTIONS: Cooling with outdoor air is not required under any one or more of the following conditions:

- 1- The fan system capacity is less than 3,500 cfm or total cooling capacity is less than 90,000 Btu/h.
- 2- The quality of the outdoor air is so poor as to require extensive treatment of the air and approval by the building official.
- 3- The need for humidification or dehumidification requires the use of more energy than is conserved by the outdoor air cooling on an annual basis.
- 4- The use of outdoor air cooling may affect the operation of other systems so as to increase the overall energy consumption of the building.
- 5- When energy recovered from an internal/external zone heat recovery system exceeds the energy conserved by outdoor air cooling on an annual basis.
- 6- When all space cooling is accomplished by a circulating liquid which transfers space heat directly or indirectly to a heat rejection device such as a cooling tower without use of a refrigeration system.
- 7- When the use of 100% outside air will cause coil frosting, controls may be added to reduce the quantity of outside air. However, the intent of this exception is to use 100% air in lieu of mechanical cooling when less energy usage will result and this exception applies only to direct expansion systems when the compressor is running.))

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: ~~((When low-pressure supply air ducts are located outside of the conditioned space, all HVAC ductwork seams and joints, both longitudinal and transverse, shall be taped and sealed with products approved by the building official only. Ductwork joints shall be mechanically fastened with a minimum of three fasteners per joint for a cylindrical duct. Use Table 5-11 for duct insulation requirements.))~~ 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 ~~((Piping))~~ Pipe Insulation: All piping ~~((installed to serve buildings (and within))~~) shall be thermally insulated in accordance with Table 5-12. ~~((For service hot water systems see section 504.7. If water pipes are outside of conditioned space then the pipe insulation requirement shall be R-3 minimum for nonrecirculating hot and cold water pipes. For recirculating service hot and cold water pipes use Table 5-12 for pipe sizes and temperatures.))~~

EXCEPTION: Piping ((insulation is not required)) 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).

**WAC 51-11-0504 Service water heating.**

504.1 Scope: The purpose of this section is to provide criteria for design and equipment selection that will produce energy savings when applied to service water heating.

504.2 Water Heaters, Storage Tanks and Boilers:

504.2.1 Performance Efficiency: All Storage water heaters shall meet the requirements of the 1987 National Appliance Energy Conservation Act and be so labeled. All electric water heaters in unheated spaces or on concrete floors shall be placed on an incompressible, insulated surface with a minimum thermal resistance of R-10.

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

504.2.2 Insulation: Heat loss from unfired hot-water storage tanks shall be limited to a maximum of 9.6 Btu/hr/ft<sup>2</sup> of external tank surface area. The design ambient temperature shall be no higher than sixty-five degrees F.

504.2.3 Combination Service Water Heating/Space Heating Boilers: Service water heating equipment shall not be dependent on year round operation of space heating boilers.

EXCEPTIONS: 1. Systems with service/space heating boilers having a standby loss Btu/h less than:

$$(13.3 \text{ pmd} + 400)/n$$

determined by the fixture count method where:

pmd = probably maximum demand in gallons/hour as determined in accordance with Chapter 37 of Standard RS-11.

n = fraction of year when outdoor daily mean temperature exceeds 64.9° F.

The standby loss is to be determined for a test period of twenty-four-hour duration while maintaining a boiler water temperature of ninety degrees F above an ambient of sixty degrees F and a five foot stack on appliance.

2. For systems where the use of a single heating unit will lead to energy savings, such unit shall be utilized.

504.3 Automatic Controls: Service water heating systems shall

be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use. Temperature setting range shall be set to one hundred twenty degrees F or forty-nine degrees C.

504.4 Shutdown: A separate switch shall be provided to permit turning off the energy supplied to electric service water heating systems. A separate valve shall be provided to permit turning off the energy supplied to the main burner(s) of all other types of service water heater systems.

#### 504.5 Swimming Pools:

504.5.1: All pool heaters shall be equipped with readily accessible ON/OFF switch to allow shutting off the operation of the heater without adjusting the thermostat setting. Controls shall be provided to allow the water temperature to be regulated from the maximum design temperature down to sixty-five degrees F.

504.5.2 Pool Covers: Heated swimming pools shall be equipped with a pool cover, approved by the building official.

504.6 Pump Operation: Circulating hot water systems shall be controlled so that the circulation pump(s) can be conveniently turned off, automatically or manually, when the hot water system is not in operation.

504.7 Pipe Insulation: (~~For recirculating and non-recirculating systems,~~) Piping shall be thermally insulated in accordance with section 503.11 (~~and Table 5-12~~).

#### 504.8 Conservation of Hot Water:

504.8.1 Showers and Lavatories: Showers and lavatories used for other than safety reasons shall be equipped with flow control devices or specially manufactured showerheads or aerators to limit the total water flow rate as set forth in chapter 51-26 WAC, as measured with both hot and cold faucets turned on to their maximum flow.

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

#### WAC 51-11-0505 ((Reserved-)) Lighting.

505.1 Lighting Controls: Hotel and motel guest rooms and guest suites shall have a master control device at the main room entry that controls all permanently installed luminaires and switched receptacles.

505.2 Lighting Power: Lighting shall comply with the Prescriptive Lighting Option in Section 1520 or the Lighting Power Allowance Option in Section 1530.

EXCEPTIONS: 1. Group R-3 occupancy and the dwelling unit portions of Group R-1 occupancy.

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

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	1	2
Glazing % Floor Area	15%	15%	15%	15%
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	U = 0.058 (R-19A)	U = 0.044 (R-19+5A)	U = 0.062 <sup>1</sup> (R-19)	U = 0.062 <sup>1</sup> (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	U = 0.043	U = 0.043	U = 0.043	U = 0.043
Slab	F = 0.69	F = 0.69	F = 0.69	F = 0.69
3.5' Depth: Walls	U = 0.041	U = 0.041	U = 0.041	U = 0.041
Slab	F = 0.64	F = 0.64	F = 0.64	F = 0.64
7' Depth: Walls	U = 0.037	U = 0.037	U = 0.037	U = 0.037
Slab	F = 0.57	F = 0.57	F = 0.57	F = 0.57
Below Grade Exterior				
Wall R-Value	R-10	R-12	R-10	R-12
2' Depth: Walls	U = 0.070	U = 0.061	U = 0.070	U = 0.061
Slab	F = 0.60	F = 0.60	F = 0.60	F = 0.60
3.5' Depth: Walls	U = 0.064	U = 0.057	U = 0.064	U = 0.057
Slab	F = 0.57	F = 0.57	F = 0.57	F = 0.57
7' Depth: Walls	U = 0.056	U = 0.050	U = 0.056	U = 0.050
Slab	F = 0.42	F = 0.42	F = 0.42	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.

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

**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. Installed components shall meet the requirements of section 602 ((and 605)). 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 91-01-112, filed 12/19/90, effective 7/1/91)

**WAC 51-11-0604 ((Electric power and lighting for Group R Occupancy-)) Reserved.**

((604.1. All electrical power and lighting systems shall comply with the requirements of section 505.))

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

WAC 51-11-0605 ((Reserved-)) Lighting. Lighting shall comply with Section 505.

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

**WAC 51-11-0625 Table 6-1.**

**TABLE 6-1  
PRESCRIPTIVE REQUIREMENTS<sup>1</sup> FOR GROUP R OCCUPANCY  
CLIMATE ZONE 1 • HEATING BY ELECTRIC RESISTANCE**

Option	Glazing Area <sup>10</sup> : % of Floor	Glazing U-Factor		Door <sup>9</sup> U-Factor	Ceiling <sup>2</sup>	Vaulted Ceiling <sup>3</sup>	Wall Above Grade	Wall <sup>•</sup> int <sup>4</sup> Below Grade	Wall <sup>•</sup> ext <sup>4</sup> Below Grade	Floor <sup>5</sup>	Slab <sup>4</sup> on Grade
		Vertical	Overhead <sup>11</sup>								
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. <sup>7</sup>	25%	0.32 <sup>7</sup>	0.58	0.20	R-38	R-30	R-19 +R-5 <sup>8</sup>	R-21	R-10	R-30	R-10
VIII. <sup>7</sup>	30%	0.29 <sup>7</sup>	0.58	0.20	R-38	R-30	R-19 +R-5 <sup>8</sup>	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 (~~(or 10-6D)~~).
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.

WAC 51-11-0626 Table 6-2.

**TABLE 6-2  
PRESCRIPTIVE REQUIREMENTS<sup>1</sup> FOR GROUP R OCCUPANCY  
CLIMATE ZONE 1 • HEATING BY OTHER FUELS**

Option	HVAC <sup>9</sup> Equip. Effic.	Glazing Area <sup>11</sup> : % of Floor	Glazing U-Factor		Door <sup>10</sup> U-Factor	Ceiling <sup>2</sup>	Vaulted Ceiling <sup>3</sup>	Wall Above Grade	Wall● int <sup>4</sup> Below Grade	Wall● ext <sup>4</sup> Below Grade	Floor <sup>5</sup>	Slab <sup>6</sup> on Grade
			Vertical	Overhead <sup>12</sup>								
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. <sup>7</sup>	Med.	25%	0.45 <sup>7</sup>	0.68	0.40	R-38	R-30	R-19	R-19	R-10	R-25	R-10
VII. <sup>7</sup>	Med.	30%	0.40 <sup>7</sup>	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 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: 0.50 maximum for glazing areas of 25% or less; 0.45 maximum for glazing areas of 30% or less.
8. ~~((This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.))~~ 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 ~~((or 10-6D)).~~
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 51-11-0627 Table 6-3.**

**TABLE 6-3  
PRESCRIPTIVE REQUIREMENTS<sup>1</sup> FOR GROUP R OCCUPANCY  
CLIMATE ZONE 2 • HEATING BY ELECTRIC RESISTANCE**

Option	Glazing Area <sup>11</sup> : % of Floor	Glazing U-Factor		Door <sup>10</sup> U-Factor	Ceiling <sup>2</sup>	Vaulted Ceiling <sup>3</sup>	Wall Above Grade	Wall● int <sup>4</sup> Below Grade	Wall● ext <sup>4</sup> Below Grade	Floor <sup>5</sup>	Slab <sup>6</sup> on Grade
		Vertical	Overhead <sup>12</sup>								
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 <sup>8</sup>	R-21	R-12	R-25	R-10
III.*	15%	0.40	0.58	0.20	R-38	R-30	R-19+R-5 <sup>8</sup>	R-21	R-12	R-30	R-10
IV.	18%	0.38	0.58	0.20	R-38	R-30	R-19+R-5 <sup>8</sup>	R-21	R-12	R-30	R-10
V.	21%	0.35	0.58	0.20	R-38Adv	R-38	R-19+R-5 <sup>8</sup>	R-21	R-12	R-30	R-10
VI. <sup>7</sup>	25%	0.30 <sup>7</sup>	0.58	0.20	R-49Adv	R-38	R-19+R-5 <sup>8</sup>	R-21	R-12	R-30	R-10
VII. <sup>7</sup>	30%	0.28 <sup>7</sup>	0.58	0.20	R-60Adv	R-38	R-21+R-7.5 <sup>9</sup>	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.
- 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: 0.33 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 (~~(or 10-6D)~~).
- 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 51-11-0628 Table 6-4.**

**TABLE 6-4  
PRESCRIPTIVE REQUIREMENTS<sup>1</sup> FOR GROUP R OCCUPANCY  
CLIMATE ZONE 2 • HEATING BY OTHER FUELS**

Option	HVAC <sup>9</sup> Equip. Effic.	Glazing Area <sup>11</sup> : % of Floor	Glazing U-Factor		Door <sup>10</sup> U-Factor	Ceiling <sup>2</sup>	Vaulted Ceiling <sup>3</sup>	Wall Above Grade	Wall● int <sup>4</sup> Below Grade	Wall● ext <sup>4</sup> Below Grade	Floor <sup>5</sup>	Slab <sup>6</sup> on Grade
			Vertical	Overhead <sup>12</sup>								
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. <sup>7</sup>	Med.	25%	0.40 <sup>7</sup>	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VIII. <sup>7</sup>	Med.	30%	0.40 <sup>7</sup>	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 ((This wall insulation requirement denotes R-19 wall cavity insulation plus R-5 foam sheathing.)) 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 ((or 10-6D)).
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 51-11-0630 Table 6-6.**

**TABLE 6-6  
LOG HOMES PRESCRIPTIVE REQUIREMENTS<sup>1\*\*</sup>  
HEATING BY OTHER FUELS**

Option	HVAC <sup>9</sup> Equip. Effic.	Glazing Area <sup>12</sup> : % of Floor	Glazing U-Factor		Door <sup>10</sup> U- Factor	Ceiling <sup>2</sup>	Vaulted Ceiling <sup>3</sup>	Wall <sup>11</sup> Above Grade	Wall <sup>●</sup> int <sup>4</sup> Below Grade	Wall <sup>●</sup> ext <sup>4</sup> Below Grade	Floor <sup>5</sup>	Slab <sup>6</sup> on Grade
			Vert- ical	Over- head <sup>13</sup>								
<b>Climate Zone 1</b>												
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. <sup>7</sup>	Med.	25%	0.45 <sup>7</sup>	0.68	0.40	R-38	R-30	R-19	R-19	R-10	R-25	R-10
VII. <sup>7</sup>	Med.	30%	0.40 <sup>7</sup>	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
<b>Climate Zone 2</b>												
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 <sup>8</sup>	0.64	0.40	R-38	R-30	R-19	R-19	R-12	R-30	R-10
VIII.	Med.	30%	0.40 <sup>8</sup>	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.
  - 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.
  - 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.
  - 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.
  - 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.
  - Doors, including all fire doors, shall be assigned default U-factors from Table 10-6C (~~or 10-6D~~).
  - Log and solid timber walls with a minimum average thickness of 3.5" are exempt from this insulation requirement.
  - 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.
  - 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 51-11-0701 ((Standards-)) Scope. The following standards shall apply to Chapters 1 through 20. The standards and portions thereof, which are referred to in various parts of this Code shall be part of the Washington State Energy Code and are hereby declared to be a part of this Code.

((ODE))

<u>REFERENCE</u>	
<u>STANDARD</u>	
NO.	TITLE AND SOURCE
RS-1	((1997 ASHRAE Fundamentals Handbook)) Same as RS-27.
RS-2	through RS-3 (Reserved.)
RS-4	ASHRAE Standard 55-92 Thermal Environmental Conditions for Human Occupancy.
RS-5	through RS-8 (Reserved.)

~~((CODE))~~

<u>REFERENCE</u> STANDARD NO.	TITLE AND SOURCE
RS-9	ASHRAE/ <u>IES</u> Standard 90.1-1989, Efficient Design of New Buildings Except New Low-Rise Residential Buildings.
RS-10	Standard for Packaged Terminal Air Conditioners and Heat Pumps, ARI Standard 310/380-93.
RS-11	<del>((1995))</del> 1999 ASHRAE HVAC Systems and Applications Handbook.
RS-12	through RS-14 (Reserved.)
RS-15	1996 ASHRAE System and Equipment Handbook.
RS-16	SMACNA, Installation Standards for Residential Heating and Air Conditioning Systems, 6th Edition, 1988.
RS-17	<del>((SMACNA, HVAC Duct Construction Standards Metal and Flexible, 2nd Edition, 1995.))</del> Same as RS-18.
RS-18	<del>((Same as Standard RS-17.))</del> <u>SMACNA, HVAC Duct Construction Standards Metal and Flexible, 2nd Edition, 1995.</u>
RS-19	SMACNA, Fibrous Glass Duct Construction Standards, 6th Edition, 1992.
RS-20	<del>((1994))</del> 1998 ASHRAE Refrigeration Handbook.
RS-21	Same as Standard RS-10.
RS-22	through RS-24 (Reserved.)
RS-25	<del>((Thermal Bridge in Sheet Metal Construction from Appendix E of Standard RS-9.))</del> Same as RS-27.
RS-26	Super Good Cents Technical Reference (Builder's Field Guide).
<u>RS-27</u>	<u>1997 ASHRAE Fundamentals Handbook.</u>
<u>RS-28</u>	<u>(Reserved.)</u>
<u>RS-29</u>	<u>Nonresidential Building Design by Systems Analysis.</u>
<u>RS-30</u>	<u>Title 10, Code of Federal Regulations (CFR), Part 430 (March 14, 1988).</u>
<u>RS-31</u>	<u>National Fenestration Rating Council (NFRC) Standard 100-1997.</u>

ACCREDITED AUTHORITATIVE AGENCIES

ANSI refers to the American National Standards Institute, Inc., 11 West 42nd Street, New York, NY 10036  
 Phone (212) 642-4900 Fax (212) 398-0023, Internet [www.ansi.org](http://www.ansi.org)

ARI refers to the Air Conditioning and Refrigeration Institute, 4301 N. Fairfax Dr., Suite 425, Arlington, VA 22203  
Phone (703) 524-8800 Fax (703) 528-3816, Internet [www.ari.org](http://www.ari.org)

ASHRAE refers to the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329  
Phone (404) 636-8400 Fax (404) 321-5478, Internet [www.ashrae.org](http://www.ashrae.org)

ASTM refers to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959  
Phone (610) 832-9585 Fax (610) 832-9555, Internet [www.astm.org](http://www.astm.org)

CTI refers to the Cooling Tower Institute, 530 Wells Fargo Drive, Suite 218, Houston, TX 77090  
Phone (281) 583-4087 Fax (281) 537-1721, Internet [www.cti.org](http://www.cti.org)

IES refers to the Illuminating Engineering Society, 120 Wall Street, Floor 17, New York, NY 10005-4001  
Phone (212) 248-5000 Fax (212) 248-5017, Internet (~~[www.ies.org](http://www.ies.org)~~)  
[www.iesna.org](http://www.iesna.org)

NFRC refers to the National Fenestration Rating Council, Incorporated, 1300 Spring Street, Suite (~~(#20)~~) 500, Silver Spring, Maryland 20910  
Phone (301) 589-NFRC Fax (301) 588-0854, Internet [www.nfrc.org](http://www.nfrc.org)

SMACNA refers to the Sheet Metal and Air Conditioning Contractors National Association, Inc., 4201 Lafayette Center Drive, P.O. Box 221230, Chantilly, VA 20153-1230  
Phone (703) 803-2980 Fax (703) 803-3732, Internet [www.smacna.org](http://www.smacna.org)

AMENDATORY SECTION (Amending WSR 91-01-112, filed 12/19/90, effective 7/1/91)

**WAC 51-11-1001 Section 1001 General.**

1001.1 Scope: The following defaults shall apply to Chapters 1 through 20. This chapter includes tables of seasonal average heat-loss coefficients for specified nominal insulation. The heat-loss coefficients may also be used for heating system sizing.

1001.2 Description: These coefficients were developed primarily from data and procedures from Standard (~~(RS-1)~~) RS-27, and taken specifically from Standard RS-26, listed in Chapter 7.

Coefficients not contained in this chapter may be computed using the procedures listed in these references if the assumptions in the following sections and Standard RS-26, listed in Chapter 7, are used, along with data from the sources referenced above.

1001.3 Air Films: Default R-values used for air films shall be as follows:

<u>R-Value</u>	<u>Condition</u>
0.17	All exterior surfaces
0.61	Interior horizontal surfaces, heat flow up
0.92	Interior horizontal surfaces, heat flow down
0.68	Interior vertical surfaces

1001.4 Compression of Insulation: Insulation which is compressed shall be rated in accordance with Table 10-A or reduction in value may be calculated in accordance with the procedures in Standard RS-27, listed in Chapter 7.

**TABLE 10-A**  
**R-Value of Fiberglass Batts Compressed within Various Depth Cavities**

Insulation R-Value at Standard Thickness												
R-Value	38	30	22	21	19	15	13	11	8	5	3	
Standard Thickness	12"	9-1/2"	6-3/4"	5-1/2"	6-1/4"	3-1/2"	3-5/8"	3-1/2"	2-1/2"	1-1/2"	3/4"	
Nominal Lumber Sizes, Inches	Actual Depth of Cavity, Inches	Insulation R-Values when Installed in a Confined Cavity										
2 x 12	11-1/4	37	--	--	--	--	--	--	--	--	--	--
2 x 10	9-1/4	32	30	--	--	--	--	--	--	--	--	--
2 x 8	7-1/4	27	26	--	--	--	--	--	--	--	--	--
2 x 6	5-1/2	--	21	20	21	18	--	--	--	--	--	--
2 x 4	3-1/2	--	--	14	--	13	15	13	11	--	--	--
2 x 3	2-1/2	--	--	--	--	--	--	9.8	--	--	--	--
2 x 2	1-1/2	--	--	--	--	--	--	6.3	6.0	5.7	5.0	--
2 x 1	3/4	--	--	--	--	--	--	--	--	--	3.2	3.0

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

**WAC 51-11-1002 Section 1002: Below grade walls and slabs.**

1002.1 General: Table 10-1 lists heat-loss coefficients for below-grade walls and floors.

Coefficients for below-grade walls are given as U-factors (Btu/hr•ft<sup>2</sup>•°F ((per square foot)) of wall area). Coefficients for below-grade slabs are listed as F-factors (Btu/hr•ft•°F per lineal foot of slab perimeter).

Below-grade wall U-factors are only valid when used with the accompanying below-grade slab F-factors, and vice versa.

1002.2 Component Description: All below-grade walls are assumed to be eight-inch concrete. The wall is assumed to extend from the slab upward to the top of the mud sill for the distance specified in Table 10-1, with six inches of concrete wall extending above grade.

Interior insulation is assumed to be fiberglass batts placed

in the cavity formed by 2x4 framing on twenty-four inch centers with one-half inch of gypsum board as the interior finish material. Exterior insulation is assumed to be applied directly to the exterior of the below-grade wall from the top of the wall to the footing. The exterior case does not assume any interior framing or sheetrock.

In all cases, the entire wall surface is assumed to be insulated to the indicated nominal level with the appropriate framing and insulation application. Coefficients are listed for wall depths of two, three and one-half, and seven feet below grade. Basements shallower than two feet should use on-grade slab coefficients.

Heat-loss calculations for wall areas above grade should use above-grade wall U-factors, beginning at the mudsill.

1002.3 Insulation Description: Coefficients are listed for the following four configurations:

1. Uninsulated: No insulation or interior finish.
2. Interior insulation: Interior 2x4 insulated wall without a thermal break between concrete wall and slab.
3. Interior insulation w/thermal break: Interior 2x4 insulated wall with R-5 rigid board providing a thermal break between the concrete wall and the slab.
4. Exterior insulation: Insulation applied directly to the exterior surface of the concrete wall.

**TABLE 10-1  
DEFAULT WALL U-FACTORS AND SLAB F-FACTORS FOR BASEMENTS**

	Below Grade Wall U-factor	Below Grade Slab F-factor
<b>2-Foot Depth Below Grade</b>		
Uninsulated	0.350	0.59
R-11 Interior	0.066	0.68
R-11 Interior w/tb	0.070	0.60
R-19 Interior	0.043	0.69
R-19 Interior w/tb	0.045	0.61
R-10 Exterior	0.070	0.60
R-12 Exterior	0.061	0.60
<b>3.5-Foot Depth Below Grade</b>		
Uninsulated	0.278	0.53
R-11 Interior	0.062	0.63
R-11 Interior w/tb	0.064	0.57
R-19 Interior	0.041	0.64
R-19 Interior w/tb	0.042	0.57
R-10 Exterior	0.064	0.57
R-12 Exterior	0.057	0.57

	Below Grade Wall U-factor	Below Grade Slab F-factor
<b>2-Foot Depth Below Grade</b>		
<b>7-Foot Depth Below Grade</b>		
Uninsulated	0.193	0.46
R-11 Interior	0.054	0.56
R-11 Interior w/tb	0.056	0.42
R-19 Interior	0.037	0.57
R-19 Interior w/tb	0.038	0.43
R-10 Exterior	0.056	0.42
R-12 Exterior	0.050	0.42

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

**WAC 51-11-1003 Section 1003: On-grade slab floors.**

1003.1 General: Table 10-2 lists heat-loss coefficients for heated on-grade slab floors, in units of Btu/h<sup>o</sup>F(•hr) per lineal foot of perimeter.

1003.2 Component Description: All on-grade slab floors are assumed to be six-inch concrete poured directly onto the earth. The bottom of the slab is assumed to be at grade line. Monolithic and floating slabs are not differentiated.

Soil is assumed to have a conductivity of 0.75 Btu/hr•F•ft<sup>2</sup>. Slabs two-feet or more below grade should use basement coefficients.

1003.3 Insulation Description: Coefficients are provided for the following three configurations:

Two-Foot (or four-foot) vertical: Insulation is applied directly to the slab exterior, extending downward from the top of the slab to a depth of two-feet (or four-feet) below grade.

Two-Foot (or four-foot) horizontal: Insulation is applied directly to the underside of the slab, and run horizontally from the perimeter inward for two-feet or four-feet. The slab edge is exposed in this configuration.

Note: A horizontal installation with a thermal break of at least R-5 at the slab edge should use the vertical-case F-factors.

Fully insulated slab: Insulation extends from the top of the slab, along the entire perimeter, and completely covers the area under the slab. Thicker perimeter insulation covers the slab edge and extends 2 feet under the slab.

**TABLE 10-2**

DEFAULT F-FACTORS FOR ON-GRADE SLABS

Insulation type	R-0	R-5	R-10	R-15
<b>Unheated Slab</b>				
Uninsulated slab	0.73	—	—	—
2-ft Horizontal (No thermal break)	—	0.70	0.70	0.69
4-ft Horizontal (No thermal break)	—	0.67	0.64	0.63
2-ft Vertical	—	0.58	0.54	0.52
4-ft Vertical	—	0.54	0.48	0.45
Fully insulated slab	—	—	0.36	—
<b>Heated Slab</b>				
Uninsulated slab	0.84	—	—	—
Fully insulated slab	—	0.74	0.55	0.44
R-5 Center (With perimeter insulation)	—	—	0.66	0.62
R-10 Center (With perimeter insulation)	—	—	—	0.51
3-ft Vertical	—	—	0.78	—

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

**WAC 51-11-1004 Section 1004: (~~(Crawlspace floors.)~~) Floors over unconditioned space.**

1004.1 General: Tables 10-3 (~~(and)~~), 10-4 and 10-4a list heat-loss coefficients for floors over (~~(crawlspace)~~) unconditioned spaces in units of Btu/h•ft<sup>2</sup>•°F (~~(•hr per square foot of floor)~~).

They are derived from procedures listed in (~~(RS-1)~~) RS-27, listed in Chapter 7, assuming an average outdoor temperature of 45° F, an average indoor temperature of 65° F, and a crawlspace area of (~~(one thousand three hundred fifty)~~) 1350 ft<sup>2</sup> and (~~(one hundred fifty)~~) 100 ft of perimeter. The crawlspace is assumed to be 2.5(~~(-)~~) feet high, with (~~(twenty-four)~~) 24 inches below grade and (~~(six)~~) 6 inches above grade.

1004.2 Crawlspace Description: Four (~~(crawlspace)~~) configurations are considered: Vented crawlspace, unvented crawlspace, (~~(enclosed and)~~) heated plenum crawlspace and exposed floor.

Vented crawlspaces: Assumed to have (~~(three)~~) 3.0 air-changes per hour, with at least (~~(one)~~) 1.0 ft<sup>2</sup> of net-free ventilation in the foundation for every three hundred ft<sup>2</sup> of crawlspace floor area. The crawlspace is not actively heated.

Floors over unheated areas, such as garages, may only use those values which have R-0 perimeter insulation.

Unvented crawlspaces: Assumed to have 1.5 air changes per hour, with less than (~~one~~) 1.0 ft<sup>2</sup> of net-free ventilation in the foundation for every three hundred ft<sup>2</sup> of crawlspace floor area. The crawlspace is not actively heated. Floors over unheated basements may only use those values which have R-0 perimeter insulation.

Heated-plenum crawlspaces: Assumed to have 0.25 air-changes per hour, with no foundation vents. Heated supply air from central furnace is blown into a crawlspace and allowed to enter the living space unducted via holes cut into the floor.

Enclosed floors: Assumes no buffer space, and a covering of one-half inch of T1-11 on the exterior of the cavity exposed to the outside air or rigid insulation below a concrete floor, such as over parking garages.

1004.3 Construction Description: Floors are assumed to be either joisted floors framed on sixteen inch centers, or post and beam on four by eight foot squares. Insulation is assumed to be installed under the subflooring between the joists or beams with no space between the insulation and the subfloor. Insulation is assumed to be uncompressed. Exposed floors also include concrete with continuous rigid insulation assumed.

Perimeter insulation is assumed to extend from the top of the rim joist to the crawlspace floor and then inward along the ground (on top of the ground cover) for at least twenty-four inches.

Floor coverings are assumed to be light carpet with rubber pad.

**TABLE 10-3  
DEFAULT U-FACTORS FOR FLOORS OVER  
VENTED CRAWLSPACE OR  
UNHEATED BASEMENT**

Nominal R-value		U-factor	
Floor	Perimeter	Post & Beam	Joists
0	0	0.112	0.134
	11	0.100	0.116
	19	0.098	0.114
	30	0.093	0.107
11	0	0.052	0.056
	11	0.048	0.052
19	0	0.038	0.041
	11	0.036	0.038
22	0	0.034	0.037
	11	0.033	0.035
25	0	0.032	0.034
	11	0.031	0.033
30	0	0.028	0.029
	11	0.027	0.028

Nominal R-value		U-factor	
Floor	Perimeter	Post & Beam	Joists
38	0	0.024	0.025
	11	0.024	0.024

**TABLE 10-4  
DEFAULT U-FACTORS FOR FLOORS OVER  
HEATED PLENUM CRAWLSPACES**

Nominal R-value Perimeter	U-factor
11	0.085
19	0.075
30	0.069

**TABLE 10-4A  
EXPOSED FLOOR**

Nominal R-value	U-factor		
	Concrete	Wood Joist	Metal Joist
R-11	0.077	0.088	0.14
R-15	0.059	0.076	0.12
R-19	0.048	0.062	0.11
R-21	0.043	0.057	0.11
R-25	0.037	0.051	0.10
R-30	0.031	0.040	0.09
R-38	0.025	0.034	0.08

Note: Crawlspace used as heated plenums have approximately 30% higher heat-loss rate than unvented crawlspaces with the same assumed ACH. Default U-values in Table 10-4 reflect this higher rate of heat loss.

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

**WAC 51-11-1005 Section 1005: Above-grade walls.**

Section 1005.1 General: Table 10-5, 10-5A and 10-5B list ((~~§~~) heat-loss coefficients for the opaque portion of above-grade wood stud frame walls (~~((Btu/°F•hr per square foot))~~), metal stud frame walls and concrete masonry walls (Btu/h•ft<sup>2</sup>•°F) respectively. They are derived from procedures listed in ((~~RS-1~~)) RS-27, listed in

Chapter 7(~~, assuming exterior air films at 7.5-mph wind speed~~).  
For intermediate floor slabs which penetrate the insulated wall,  
use the concrete wall U-factors in Table 10-5B.

Insulation is assumed to uniformly fill the entire cavity and to be installed as per manufacturer's directions. All walls are assumed to be finished on the inside with one-half inch gypsum wallboard, and on the outside with either beveled wood siding over one-half inch plywood sheathing or with five-eighths inch T1-11 siding. Insulated sheathing (either interior or exterior) is assumed to cover the entire opaque wall surface.

1005.2 Framing Description: For wood stud frame walls, three framing types are considered, and defined as follows:

Standard: Studs framed on sixteen inch centers with double top plate and single bottom plate. Corners use three studs and each opening is framed using two studs. Headers consist of double 2X or single 4X material with an air space left between the header and the exterior sheathing. Interior partition wall/exterior wall intersections use two studs in the exterior wall.

Framing weighting factors:	Studs and plates	.19
	Insulated cavity	.77
	Headers	.04

Intermediate: Studs framed on sixteen inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and each opening is framed by two studs. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.18
	Insulated cavity	.78
	Headers	.04

Advanced: Studs framed on twenty-four inch centers with double top plate and single bottom plate. Corners use two studs or other means of fully insulating corners, and one stud is used to support each header. Headers consist of double 2X material with R-10 insulation between the header and exterior sheathing. Interior partition wall/exterior wall intersections are fully insulated in the exterior wall.

Framing weighting factors:	Studs and plates	.13
	Insulated cavity	.83
	Headers	.04

1005.3 Component Description: Default coefficients for four types of walls are listed: single-stud walls, metal stud walls, strap walls, and double-stud walls.

Single-Stud Wall: Assumes either 2x4 or 2x6 studs framed on sixteen or twenty-four inch centers. Headers are solid for 2x4

walls and double 2x for 2x6 walls, with either dead-air or rigid-board insulation in the remaining space.

**Metal Stud Wall:** Assumes metal studs spaced on 16 or 24 inch centers with insulation installed to fill wall cavities. Continuous rigid board insulation is applied without creating uninsulated voids in the wall assembly.

**Strap Wall:** Assumes 2x6 studs framed on sixteen or twenty-four inch centers. 2x3 or 2x4 strapping is run horizontally along the interior surface of the wall to provide additional space for insulation.

**Double-Stud Wall:** Assumes an exterior structural wall and a separate interior, non-structural wall. Insulation is placed in both wall cavities and in the space between the ((two)) 2 walls. Stud spacing is assumed to be on ((~~twenty-four~~)) 24 inch centers for both walls.

**TABLE 10-5**  
**DEFAULT U-FACTORS FOR ABOVE-GRADE WALLS**

**2 x 4 Single Wood Stud: R-11 Batt**

R-value of Foam Board	Siding Material/Framing Type			
	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
0	0.088	0.084	0.094	0.090
1	0.080	0.077	0.085	0.082
2	0.074	0.071	0.078	0.075
3	0.069	0.066	0.072	0.070
4	0.064	0.062	0.067	0.065
5	0.060	0.058	0.063	0.061
6	0.056	0.055	0.059	0.057
7	0.053	0.052	0.055	0.054
8	0.051	0.049	0.052	0.051
9	0.048	0.047	0.050	0.049
10	0.046	0.045	0.047	0.046
11	0.044	0.043	0.045	0.044
12	0.042	0.041	0.043	0.042

**NOTE:**

Nominal Batt R-value:  
R-11 at 3.5 inch thickness

Installed Batt R-value:  
R-11 in 3.5 inch cavity

**2 x 4 Single Wood Stud: R-13 Batt**

Siding Material/Framing Type				
	Lapped Wood		T1-11	
R-value of Foam Board	STD	ADV	STD	ADV
0	0.082	0.078	0.088	0.083
1	0.075	0.072	0.080	0.076
2	0.069	0.066	0.073	0.070
3	0.065	0.062	0.068	0.065
4	0.060	0.058	0.063	0.061
5	0.057	0.055	0.059	0.057
6	0.053	0.052	0.056	0.054
7	0.051	0.049	0.052	0.051
8	0.048	0.047	0.050	0.048
9	0.046	0.045	0.047	0.046
10	0.044	0.043	0.045	0.044
11	0.042	0.041	0.043	0.042
12	0.040	0.039	0.041	0.040

**NOTE:**

Nominal Batt R-value:  
R-13 at 3.63 inch thickness

Installed Batt R-value:  
R-12.7 in 3.5 inch cavity

**2 x 4 Single Wood Stud: R-15 Batt**

Siding Material/Framing Type				
	Lapped Wood		T1-11	
R-value of Foam Board	STD	ADV	STD	ADV
0	0.076	0.071	0.081	0.075
1	0.069	0.065	0.073	0.069
2	0.064	0.061	0.068	0.069
3	0.060	0.057	0.063	0.059
4	0.056	0.053	0.059	0.056
5	0.053	0.051	0.055	0.052
6	0.050	0.048	0.052	0.050
7	0.047	0.046	0.049	0.047
8	0.045	0.044	0.047	0.045
9	0.043	0.042	0.044	0.043
10	0.041	0.040	0.042	0.041
11	0.039	0.038	0.041	0.039
12	0.038	0.037	0.039	0.038

**NOTE:**

Nominal Batt R-value:  
R-15 at 3.5 inch thickness

Installed Batt R-value:  
R-15 in 3.5 inch cavity

**2 x 6 Single Wood Stud: R-19 Batt**

Siding Material/Framing Type						
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
0	0.062	0.058	0.055	0.065	0.061	0.058
1	0.058	0.055	0.052	0.060	0.057	0.055
2	0.054	0.052	0.050	0.056	0.054	0.051
3	0.051	0.049	0.047	0.053	0.051	0.049
4	0.048	0.046	0.045	0.050	0.048	0.046
5	0.046	0.044	0.043	0.048	0.046	0.044
6	0.044	0.042	0.041	0.045	0.044	0.042
7	0.042	0.040	0.039	0.043	0.042	0.040
8	0.040	0.039	0.038	0.041	0.040	0.039
9	0.038	0.037	0.035	0.039	0.038	0.037
10	0.037	0.036	0.035	0.038	0.037	0.036
11	0.036	0.035	0.034	0.036	0.035	0.035
12	0.034	0.033	0.033	0.035	0.034	0.033

**NOTE:**

Nominal Batt R-value:  
R-19 at 6 inch thickness

Installed Batt R-value:  
R-18 in 5.5 inch cavity

**2 x 6 Single Wood Stud: R-21 Batt**

Siding Material/Framing Type						
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
0	0.057	0.054	0.051	0.060	0.056	0.053
1	0.054	0.051	0.048	0.056	0.053	0.050
2	0.050	0.048	0.045	0.052	0.050	0.047
3	0.048	0.045	0.043	0.049	0.047	0.045
4	0.045	0.043	0.041	0.047	0.045	0.043
5	0.043	0.041	0.040	0.044	0.042	0.041
6	0.041	0.039	0.038	0.042	0.041	0.039
7	0.039	0.038	0.036	0.040	0.039	0.037
8	0.038	0.036	0.035	0.039	0.037	0.036
9	0.036	0.035	0.034	0.037	0.036	0.035
10	0.035	0.034	0.033	0.036	0.035	0.033
11	0.033	0.033	0.032	0.034	0.033	0.032
12	0.032	0.031	0.031	0.033	0.032	0.031

**NOTE:**

Nominal Batt R-value:  
R-21 at 5.5 inch thickness

Installed Batt R-value:  
R-21 in 5.5 inch cavity

**2 x 6 Single Wood Stud: R-22 Batt**

Siding Material/Framing Type						
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
0	0.059	0.055	0.052	0.062	0.058	0.054
1	0.055	0.052	0.049	0.057	0.054	0.051
2	0.052	0.049	0.047	0.054	0.051	0.048
3	0.049	0.046	0.044	0.050	0.048	0.046
4	0.046	0.044	0.042	0.048	0.046	0.044
5	0.044	0.042	0.041	0.045	0.043	0.042
6	0.042	0.040	0.039	0.043	0.042	0.040
7	0.040	0.039	0.037	0.041	0.040	0.038
8	0.038	0.037	0.036	0.039	0.038	0.037
9	0.037	0.036	0.035	0.038	0.037	0.035
10	0.035	0.034	0.033	0.036	0.035	0.034
11	0.034	0.033	0.032	0.035	0.034	0.033
12	0.033	0.032	0.031	0.034	0.033	0.032

**NOTE:**

Nominal Batt R-value:  
R-22 at 6.75 inch thickness

Installed Batt R-value:  
R-20 in 5.5 inch cavity

**2 x 6 Single Wood Stud: Two R-11 Batts**

Siding Material/Framing Type						
	Lapped Wood			T1-11		
R-value of Foam Board	STD	INT	ADV	STD	INT	ADV
0	0.060	0.057	0.054	0.063	0.059	0.056
1	0.056	0.053	0.051	0.059	0.056	0.053
2	0.053	0.050	0.048	0.055	0.052	0.050
3	0.050	0.048	0.046	0.052	0.049	0.047
4	0.047	0.045	0.044	0.049	0.047	0.045
5	0.045	0.043	0.042	0.046	0.045	0.043
6	0.043	0.041	0.040	0.044	0.043	0.041
7	0.041	0.040	0.038	0.042	0.041	0.039
8	0.039	0.038	0.037	0.040	0.039	0.038
9	0.038	0.037	0.036	0.039	0.038	0.036
10	0.036	0.035	0.034	0.037	0.036	0.035
11	0.035	0.034	0.033	0.036	0.035	0.034
12	0.034	0.033	0.032	0.034	0.034	0.033

**NOTE:**

Nominal Batt R-value:  
R-22 at 7 inch thickness

Installed Batt R-value:  
R-18.9 in 5.5 inch cavity

**2 x 8 Single Stud: R-25 Batt**

Siding Material/Framing Type						
R-value of Foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	0.051	0.047	0.045	0.053	0.049	0.046
1	0.048	0.045	0.043	0.049	0.046	0.044
2	0.045	0.043	0.041	0.047	0.044	0.042
3	0.043	0.041	0.039	0.044	0.042	0.040
4	0.041	0.039	0.037	0.042	0.040	0.038
5	0.039	0.037	0.036	0.040	0.038	0.037
6	0.037	0.036	0.035	0.038	0.037	0.036
7	0.036	0.035	0.033	0.037	0.035	0.034
8	0.035	0.033	0.032	0.035	0.034	0.033
9	0.033	0.032	0.031	0.034	0.033	0.032
10	0.032	0.031	0.030	0.033	0.032	0.031
11	0.031	0.030	0.029	0.032	0.031	0.030
12	0.030	0.029	0.028	0.031	0.030	0.029

**NOTE:**

Nominal Batt R-value:  
R-25 at 8 inch thickness

Installed Batt R-value:  
R-23.6 in 7.25 inch cavity

**2 x 6: Strap Wall**

	Siding Material/Frame Type			
	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
R-19 + R-11 Batts	0.036	0.035	0.038	0.036
R-19 + R-8 Batts	0.041	0.039	0.042	0.040

**2 x 6 + 2 x 4: Double Wood Stud**

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV
R-19	-----	R-11	0.040	0.037	0.041	0.038
R-19	-----	R-19	0.034	0.031	0.035	0.032
R-19	R-8	R-11	0.029	0.028	0.031	0.029
R-19	R-11	R-11	0.027	0.026	0.028	0.027
R-19	R-11	R-19	0.024	0.023	0.025	0.023
R-19	R-19	R-19	0.021	0.020	0.021	0.020

**2 x 4 + 2 x 4: Double Wood Stud**

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
Exterior	Middle	Interior	STD	ADV	STD	ADV

2 x 4 + 2 x 4: Double Wood Stud

Batt Configuration			Siding Material/Frame Type			
			Lapped Wood		T1-11	
R-11	-----	R-11	0.050	0.046	0.052	0.048
R-19	-----	R-11	0.039	0.037	0.043	0.039
R-11	R-8	R-11	0.037	0.035	0.036	0.036
R-11	R-11	R-11	0.032	0.031	0.033	0.032
R-13	R-13	R-13	0.029	0.028	0.029	0.028
R-11	R-19	R-11	0.026	0.026	0.027	0.026

Log Walls

NOTE:

R-value of wood:  
R-1.25 per inch  
thickness

Average wall thickness  
90% average log  
diameter

Average Log Diameter, Inches	U-factor
6	0.148
8	0.111
10	0.089
12	0.074
14	0.063
16	0.056

Stress Skin Panel

NOTE:

R-value of expanded polystyrene: R-3.85 per inch

Framing: 6%  
Spline: 8%

No thermal bridging between interior and exterior splines

Panel Thickness, Inches	U-factor
3 1/2	0.071
5 1/2	0.048
7 1/4	0.037
9 1/4	0.030
11 1/4	0.025

**Metal Stud Walls:** The nominal R-values in Table 10-5A may be used for purposes of calculating metal stud wall section U-factors in lieu of the ASHRAE zone calculation method as provided in Chapter 24 of Standard RS-27.

TABLE 10-5A

**Default U-factors for Overall Assembly Metal Stud Walls, Effective R-values for Metal Framing and Cavity Only, and Default Metal Building U-factors**

**OVERALL ASSEMBLY U-FACTORS FOR METAL STUD WALLS**

Metal Framing	R-Value of Continuous Foam Board Insulation	Cavity Insulation					
		R-11	R-13	R-15	R-19	R-21	R-25
16" o.c.	R-0 (none)	U-0.14	U-0.13	U-0.12	U-0.10	U-0.097	U-0.091
	R-1	U-0.12	U-0.12	U-0.11	U-0.094	U-0.089	U-0.083
	R-2	U-0.11	U-0.10	U-0.099	U-0.086	U-0.081	U-0.077
	R-3	U-0.10	U-0.095	U-0.090	U-0.079	U-0.075	U-0.071
	R-4	U-0.091	U-0.087	U-0.082	U-0.073	U-0.070	U-0.067
	R-5	U-0.083	U-0.080	U-0.076	U-0.068	U-0.065	U-0.062
	R-6	U-0.077	U-0.074	U-0.071	U-0.064	U-0.061	U-0.059
	R-7	U-0.071	U-0.069	U-0.066	U-0.060	U-0.058	U-0.055
	R-8	U-0.067	U-0.064	U-0.062	U-0.057	U-0.055	U-0.053
	R-9	U-0.062	U-0.060	U-0.058	U-0.054	U-0.052	U-0.050
	R-10	U-0.059	U-0.057	U-0.055	U-0.051	U-0.049	U-0.048

24" o.c.	R-0 (none)	U-0.13	U-0.12	U-0.11	U-0.091	U-0.085	U-0.079
	R-1	U-0.11	U-0.10	U-0.098	U-0.084	U-0.078	U-0.073
	R-2	U-0.10	U-0.091	U-0.089	U-0.077	U-0.073	U-0.068
	R-3	U-0.092	U-0.083	U-0.082	U-0.072	U-0.068	U-0.064
	R-4	U-0.084	U-0.077	U-0.076	U-0.067	U-0.063	U-0.060
	R-5	U-0.078	U-0.071	U-0.070	U-0.063	U-0.060	U-0.057
	R-6	U-0.072	U-0.067	U-0.066	U-0.059	U-0.056	U-0.054
	R-7	U-0.067	U-0.063	U-0.062	U-0.056	U-0.053	U-0.051
	R-8	U-0.063	U-0.059	U-0.058	U-0.053	U-0.051	U-0.048
	R-9	U-0.059	U-0.056	U-0.055	U-0.050	U-0.048	U-0.046
	R-10	U-0.056	U-0.053	U-0.052	U-0.048	U-0.046	U-0.044

**EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY**

	Cavity		Insulation		
	Nominal Depth, Inches	Actual Depth, Inches	Nominal R-Value	Effective R-Value	
				16" O.C.	24" O.C.
Air Cavity	any	any	R-0.91 (air)	0.79	0.91
Wall	4	3-1/2	R-11	5.5	6.6
	4	3-1/2	R-13	6.0	7.2
	4	3-1/2	R-15	6.4	7.8
	6	5-1/2	R-19	7.1	8.6
	6	5-1/2	R-21	7.4	9.0
	8	7-1/4	R-25	7.8	9.6
Roof	Insulation is uncompressed		R-11	5.5	6.1
			R-19	7.0	9.1

	Cavity		Insulation		
	Nominal Depth, Inches	Actual Depth, Inches	Nominal R-Value	Effective R-Value	
				16" O.C.	24" O.C.
			R-30	9.3	11.4

### DEFAULT METAL BUILDING U-FACTORS

	R-10	R-11	R-13	R-19	R-24	R-30
Faced fiber glass blanket insulation rolled over and perpendicular to structural frame. Metal covering sheets fastened to the frame, holding insulation in place.	0.133	0.127	0.114	0.091	na	na
Faced fiber glass batt insulation suspended between structural frame. Metal covering sheets fastened directly to frame.	0.131	0.123	0.107	0.079	0.065	0.057
Faced fiber glass blanket insulation rolled over and perpendicular to structural frame. Rigid insulation blocks placed over insulation to align with structural frame.	0.102	0.096	0.084	0.065	na	na
Faced fiber glass batt insulation suspended between structural frame. Rigid insulation blocks placed over insulation to align with structural frame.	0.099	0.093	0.080	0.059	0.048	0.041

**Concrete Masonry Walls:** The nominal R-values in Table 10-5B may be used for purposes of calculating concrete masonry wall section U-factors in lieu of the ASHRAE isothermal planes calculation method as provided in Chapter 24 of Standard RS-27.

**TABLE 10-5B**  
Default U-Factors for Concrete and Masonry Walls

8" CONCRETE MASONRY				
WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with UngROUTED Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.40	0.23	0.24	0.43
R-5 Interior Insulation, Wood Furring	0.14	0.11	0.12	0.15
R-6 Interior Insulation, Wood Furring	0.14	0.11	0.11	0.14
R-10.5 Interior Insulation, Wood Furring	0.11	0.09	0.09	0.11
R-8 Interior Insulation, Metal Clips	0.11	0.09	0.09	0.11
R-6 Exterior Insulation	0.12	0.10	0.10	0.12
R-10 Exterior Insulation	0.08	0.07	0.07	0.08
R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block	0.11	0.09	0.09	0.12

**12" CONCRETE MASONRY**

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with UngROUTED Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.35	0.17	0.18	0.33
R-5 Interior Insulation, Wood Furring	0.14	0.10	0.10	0.13
R-6 Interior Insulation, Wood Furring	0.13	0.09	0.10	0.13
R-10.5 Interior Insulation, Wood Furring	0.11	0.08	0.08	0.10
R-8 Interior Insulation, Metal Clips	0.10	0.08	0.08	0.09
R-6 Exterior Insulation	0.11	0.09	0.09	0.11
R-10 Exterior Insulation	0.08	0.06	0.06	0.08
R-9.5 Rigid Polystyrene Integral Insulation, Two Webbed Block	0.11	0.08	0.09	0.12

**8" CLAY BRICK**

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with UngROUTED Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Block, Both Sides	0.50	0.31	0.32	0.56
R-5 Interior Insulation, Wood Furring	0.15	0.13	0.13	0.16
R-6 Interior Insulation, Wood Furring	0.15	0.12	0.12	0.15
R-10.5 Interior Insulation, Wood Furring	0.12	0.10	0.10	0.12
R-8 Interior Insulation, Metal Clips	0.11	0.10	0.10	0.11
R-6 Exterior Insulation	0.12	0.11	0.11	0.13
R-10 Exterior Insulation	0.08	0.08	0.08	0.09

**6" CONCRETE POURED OR PRECAST**

WALL DESCRIPTION	CORE TREATMENT			
	Partial Grout with UngROUTED Cores			Solid Grout
	Empty	Loose-fill insulated		
		Perlite	Vermiculite	
Exposed Concrete, Both Sides	NA	NA	NA	0.61
R-5 Interior Insulation, Wood Furring	NA	NA	NA	0.16
R-6 Interior Insulation, Wood Furring	NA	NA	NA	0.15
R-10.5 Interior Insulation, Wood Furring	NA	NA	NA	0.12
R-8 Interior Insulation, Metal Clips	NA	NA	NA	0.12
R-6 Exterior Insulation	NA	NA	NA	0.13
R-10 Exterior Insulation	NA	NA	NA	0.09

**Notes for Default Table 10-5B**

1. Grouted cores at 40" x 48" on center vertically and horizontally in partial grouted walls.
2. Interior insulation values include 1/2" gypsum board on the inner surface.
3. Furring and stud spacing is 16" on center. Insulation is assumed to fill furring space and is not compressed.
4. Intermediate values may be interpolated using this table. Values not contained in this table may be computed using the procedures listed in Standard RS-27.

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

1006.1 (~~Untested~~) Glazing and Doors without NFRC Certification: (~~Untested~~) Glazing and doors that do not have NFRC certification shall be assigned the (~~U-factors from Tables 10-6A, 10-6B, 10-6C, 10-6D, or 10-6E as appropriate.~~) following U-factors:

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

<b>Vertical Glazing</b>		
	<b>U-Factor</b>	
	<b>Any Frame</b>	<b>Vinyl/Wood Frame</b>
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 <sup>(0.40)</sup> , Fixed	0.60	0.50
1/2 Inch Argon, Low-e <sup>(0.10)</sup> , Fixed	0.50	0.40

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

<b>Opaque Doors</b>	
	<b>U-Factor</b>
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

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

Description <sup>1,2,3,4</sup>		Frame Type <sup>5,6</sup>			
		Aluminum	Aluminum Thermal Break <sup>7</sup>	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/ft<sup>2</sup>/°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 10-6B'**  
**Group R Occupancy: DEFAULT U-FACTORS FOR VERTICAL GLAZING**  
**FOR SMALL BUSINESSES**

DESCRIPTION <sup>2,3,4,5,6</sup>	FRAME TYPE <sup>7,8</sup>			
	ALUMINUM	ALUM. THERMAL BREAK <sup>9</sup>	WOOD/VINYL	ALUM. CLAD WOOD/REINFORCED VINYL <sup>10</sup>
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	0.44
Double, Low-e1 1/2"	0.61	0.47	0.39	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.
- 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/ft<sup>2</sup>/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  
DEFAULT U-FACTORS FOR WOOD AND STEEL DOORS**

Nominal Door Thickness, inches	Description	No Storm Door	Wood Storm Door <sup>c</sup>	Metal Storm Door <sup>d</sup>
<b>Wood Doors<sup>b</sup></b>				
1-3/8	Panel door with 7/16 inch panels <sup>a</sup>	0.57	0.33	0.37
1-3/8	Hollow core flush door	0.47	0.30	0.32
1-3/8	Solid core flush door	0.39	0.26	0.28
1-3/4	Panel door with 7/16 inch panels <sup>a</sup>	0.57	0.33	0.36
1-3/4	Hollow core flush door	0.46	0.29	0.32

Nominal Door Thickness, Inches	Description	No Storm Door	Wood Storm Door <sup>e</sup>	Metal Storm Door <sup>f</sup>
1-3/4	Panel door with 3/4 inch panels <sup>e</sup>	0.40	0.27	0.29
1-3/4	Panel door with 1-1/8 inch panels <sup>e</sup>	0.39	0.26	0.28
1-3/4	Solid core flush door	0.33	0.28	0.25
2-1/4	Solid core flush door	0.27	0.20	0.21
<b>Steel Doors<sup>d</sup></b>				
1-3/4	Fiberglass or mineral wool core w/ steel stiffeners, no thermal break <sup>f</sup>	0.60	—	—
1-3/4	Paper honeycomb core without thermal break <sup>f</sup>	0.56	—	—
1-3/4	Solid urethane foam core without thermal break <sup>f</sup>	0.40	—	—
1-3/4	Solid fire rated mineral fiberboard core without thermal break <sup>f</sup>	0.38	—	—
1-3/4	Polystyrene core without thermal break (18 gage commercial steel) <sup>f</sup>	0.35	—	—
1-3/4	Polyurethane core without thermal break (18 gage commercial steel) <sup>f</sup>	0.29	—	—
1-3/4	Polyurethane core without thermal break (24 gage commercial steel) <sup>f</sup>	0.29	—	—
1-3/4	Polyurethane core w/ thermal break & wood perimeter (24 gage commercial steel) <sup>f</sup>	0.20	—	—
1-3/4	Solid urethane foam core with thermal break	0.19	0.16	0.17

Note: All U-factors for exterior doors in this table are for doors with no glazing, except for the storm doors which are in addition to the main exterior door. Any glazing area in exterior doors should be included with the appropriate glass type and analyzed. Interpolation and moderate extrapolation are permitted for door thicknesses other than those specified.

- a Values are based on a nominal 32 by 80 in. door size with no glazing.
- b Outside air conditions: 15 mph wind speed, 0°F air temperature; inside air conditions: natural convection, 70°F air temperature.
- c Values for wood storm door are for approximately 50 percent glass area.
- d Values for metal storm door are for any percent glass area.
- e 55 percent panel area.
- f ASTM C 236 hotbox data on a nominal 3 by 7 ft door size with no glazing.

The U-factors in Table 6C are for exterior wood and steel doors. The values given for wood doors were calculated, and those for steel doors were taken from hotbox tests (Sabine et al. 1975; Yellot 1965) or from manufacturer's test reports. An outdoor surface conductance of 6.0 Btu/h•ft<sup>2</sup>•°F was used, and the indoor surface conductance was taken as 1.4 Btu/h•ft<sup>2</sup>•°F for vertical surfaces with horizontal heat flow. All values given are for exterior doors without glazing. If an exterior door contains glazing, refer to Table 10-6D.)

**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
	<b>SWINGING DOORS (Rough opening - 38 in. x 82 in.)</b>				

Slab Doors

Wood slab in wood frame <sup>a</sup>	0.46
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<b>Door Type</b>	<b>No Glazing</b>	<b>Single Glazing</b>	<b>Double Glazing with 1/4 in. Airspace</b>	<b>Double Glazing with 1/2 in. Airspace</b>	<b>Double Glazing with e=0.10, 1/2 in. Argon</b>
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
45% glazing (22 in. x 64 in. lite)	=	0.69	0.49	0.46	0.39
More than 50% glazing		Use Table 10-6A			
<b>Insulated steel slab with wood edge in wood frame<sup>a</sup></b>	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			
<b>Foam insulated steel slab with metal edge in steel frame<sup>b</sup></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			
<b>Cardboard honeycomb slab with metal edge in steel frame<sup>b</sup></b>	0.61				
<b>Style and Rail Doors</b>					
Sliding glass doors/French doors		Use Table 10-6A			
<b>Site-Assembled Style and Rail Doors</b>					
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
<b>REVOLVING DOORS (Rough opening - 82 in. x 84 in.)</b>					
Aluminum in aluminum frame					
Open	=	1.32	=	=	=
Closed	=	0.65	=	=	=
<b>SECTIONAL OVERHEAD DOORS (Nominal - 10 ft x 10 ft)</b>					
Uninsulated steel (nominal U =1.15) <sup>c</sup>	1.15	=	=	=	=
Insulated steel (nominal U =0.11) <sup>c</sup>	0.24	=	=	=	=
Insulated steel with thermal break (nominal U = 0.08) <sup>c</sup>	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**  
**((DEFAULT U-FACTORS FOR GLAZED DOORS?))**  
**Group R Occupancy: DEFAULT U-FACTORS FOR GLAZED DOORS**  
**See Table 10-6C**

Description <sup>2,3,4</sup>	((Door Material			
	Insulated <sup>5</sup>		Wood <sup>7</sup>	
	Full-Lite <sup>6</sup>	Half-Lite <sup>6,8</sup>	Full-Lite <sup>9</sup>	Half-Lite <sup>10</sup>
Double, Clear 1/4"	0.39	0.31	0.47	0.42
Double, Clear 1/4"+ argon	0.37	0.30	0.45	0.41
Double, Low-e4 1/4"	0.36	0.30	0.44	0.41
Double, Low-e2 1/4"	0.35	0.29	0.43	0.40
Double, Low-e1 1/4"	0.24	0.28	0.41	0.39
Double, Low-e4 1/4"+ argon	0.33	0.28	0.41	0.39
Double, Low-e2 1/4"+ argon	0.31	0.26	0.39	0.38
Double, Low-e1 1/4"+ argon	0.31	0.26	0.38	0.37
Double, Clear 3/8"	0.37	0.30	0.45	0.41
Double, Clear 3/8"+ argon	0.36	0.29	0.44	0.41
Double, Low-e4 3/8"	0.34	0.28	0.42	0.40
Double, Low-e2 3/8"	0.33	0.28	0.41	0.39
Double, Low-e1 3/8"	0.21	0.26	0.38	0.37
Double, Low-e4 3/8"+ argon	0.32	0.27	0.40	0.38
Double, Low-e2 3/8"+ argon	0.29	0.25	0.37	0.37
Double, Low-e1 3/8"+ argon	0.29	0.25	0.36	0.36
Double, Clear 1/2"	0.36	0.29	0.44	0.41
Double, Clear 1/2"+ argon	0.34	0.28	0.42	0.40
Double, Low-e4 1/2"	0.32	0.27	0.40	0.38
Double, Low-e2 1/2"	0.30	0.26	0.38	0.37
Double, Low-e1 1/2"	0.29	0.25	0.36	0.36
Double, Low-e4 1/2"+ argon	0.30	0.26	0.38	0.37
Double, Low-e2 1/2"+ argon	0.28	0.25	0.36	0.36
Double, Low-e1 1/2"+ argon	0.28	0.24	0.34	0.35
Triple, Clear 1/4"	0.31	0.26	0.39	0.38
Triple, Clear 1/4"+ argon	0.29	0.25	0.37	0.37
Triple, Low-e4 1/4"	0.30	0.26	0.38	0.37
Triple, Low-e2 1/4"	0.29	0.25	0.37	0.36
Triple, Low-e4 1/4"+ argon	0.27	0.24	0.35	0.35
Triple, Low-e2 1/4"+ argon	0.26	0.24	0.34	0.35

**Footnotes to Table 10-6D**

- † Subtract 0.02 from the listed default U-factor for insulated spacers. Insulated spacer material includes 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.  
Products with air spaces different than those listed above shall use the value for 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, CO<sub>2</sub>, SF<sub>6</sub> and argon/SF<sub>6</sub> mixtures.  
The following conversion factor shall apply to Krypton gas-filled units:  
1/4 inch or greater airspace of Krypton gas fill = 1/2 inch air space Argon gas fill.~~
- 5 ~~Dividers placed between glazing: The U-factors 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.~~
- 6 ~~Insulated= Any urethane insulated foam core door with a thermal break. Thermal Break= A thermal break door shall incorporate the following design characteristics:  
a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/h•ft<sup>2</sup>•°F; and  
b) The thermal break material shall not be less than 0.210 inches.~~
- 7 ~~Wood= any wood door.~~
- 8 ~~Full-Lite= A door that consists of more than 50% glazing.~~
- 9 ~~Add 0.05 to the listed U-factor for Full-Lite values if the insulated door does not have a thermal break.~~
- 10 ~~Half-Lite= A door that consists of 50% or less glazing.~~
- 11 ~~Add 0.06 to the listed U-factor for Half-Lite values if the insulated door does not have a thermal break:))~~

**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 acrylic/polycarb	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 argon	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 argon	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 argon	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 argon	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

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
argon	U-0.87	U-0.69	U-0.64	U-0.48
Triple Glazing, $e=0.20$				
air	U-0.86	U-0.68	U-0.63	U-0.47
argon	U-0.82	U-0.63	U-0.59	U-0.43
Triple Glazing, $e=0.20$ on 2 surfaces				
air	U-0.82	U-0.64	U-0.60	U-0.44
argon	U-0.79	U-0.60	U-0.56	U-0.40
Triple Glazing, $e=0.10$ on 2 surfaces				
air	U-0.81	U-0.62	U-0.58	U-0.42
argon	U-0.77	U-0.58	U-0.54	U-0.38
Quadruple Glazing, $e=0.10$ on 2 surfaces				
air	U-0.78	U-0.59	U-0.55	U-0.39
argon	U-0.74	U-0.56	U-0.52	U-0.36
krypton	U-0.70	U-0.52	U-0.48	U-0.32

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 98-03-003, filed 1/8/98, effective 7/1/98)

**WAC 51-11-1007 Section 1007 Ceilings.**

1007.1 General: Table 10-7 lists heat-loss coefficients for the opaque portion of exterior ceilings below vented attics, vaulted ceilings, and roof decks in units of (~~Btu/hr·°F per square foot~~) Btu/h·ft<sup>2</sup>·°F of ceiling.

They are derived from procedures listed in Standard (~~RS-1~~) RS-27, listed in Chapter 7. Ceiling U-factors are modified for the buffering effect of the attic, assuming an indoor temperature of 65° F and an outdoor temperature of 45° F.

**Metal Framed Ceilings:** The nominal R-values in Table 10-5A - EFFECTIVE R-VALUES FOR METAL FRAMING AND CAVITY ONLY may be used for purposes of calculating metal framed ceiling section U-factors in lieu of the ASHRAE zone calculation method as provided in Chapter 24 of Standard RS-27.

1007.2 Component Description: The (~~three~~) four types of ceilings are characterized as follows:

Ceilings Below a Vented Attic: Attic insulation is assumed to

be blown-in, loose-fill fiberglass with a K-value of 2.6 hr•ft<sup>3</sup>•°F/Btu per inch. Full bag count for specified R-value is assumed in all cases. Ceiling dimensions for flat ceiling calculations are forty-five by thirty feet, with a gabled roof having a 4/12 pitch. The attic is assumed to vent naturally at the rate of three air changes per hour through soffit and ridge vents. A void fraction of 0.002 is assumed for all attics with insulation baffles. Standard-framed, unbaffled attics assume a void fraction of 0.008.

Attic framing is either standard or advanced. Standard framing assumes tapering of insulation depth around the perimeter with resultant decrease in thermal resistance. An increased R-value is assumed in the center of the ceiling due to the effect of piling leftover insulation. Advanced framing assumes full and even depth of insulation extending to the outside edge of exterior walls. Advanced framing does not change from the default value.

U-factors for flat ceilings below vented attics with standard framing may be modified with the following table:

Roof Pitch	U-Factor for Standard Framing	
	R-30	R-38
4/12	.036	.031
5/12	.035	.030
6/12	.034	.029
7/12	.034	.029
8/12	.034	.028
9/12	.034	.028
10/12	.033	.028
11/12	.033	.027
12/12	.033	.027

Vented scissors truss attics assume a ceiling pitch of 2/12 with a roof pitch of either 4/12 or 5/12. Unbaffled standard framed scissors truss attics are assumed to have a void fraction of 0.016.

**Vaulted Ceilings:** Insulation is assumed to be fiberglass batts installed in roof joist cavities. In the vented case, at least 1.5-inches between the top of the batts and the underside of the roof sheathing is left open for ventilation in each cavity. A ventilation rate of (~~three~~) 3.0 air changes per hour is assumed. In the unvented or dense pack case, the ceiling cavity is assumed to be fully packed with insulation, leaving no space for ventilation.

**Roof Decks:** Rigid insulation is applied to the top of roof decking with no space left for ventilation. Roofing materials are attached directly on top of the insulation. Framing members are often left exposed on the interior side.

**Metal Truss Framing:** Overall system tested values for the roof/ceiling U<sub>o</sub> for metal framed truss assemblies from approved laboratories shall be used, when such data is acceptable to the building official.

Alternatively, the  $U_o$  for roof/ceiling assemblies using metal truss framing may be obtained from Tables 10-7A, 10-7B, 10-7C, 10-7D and 10-7E.

**TABLE 10-7  
DEFAULT U-FACTORS FOR CEILINGS**

**Ceilings Below Vented Attics**

		Standard Frame	Advanced Frame
<b>Flat Ceiling</b>		<b>Baffled</b>	
R-19		0.049	0.047
R-30		0.036	0.032
R-38		0.031	0.026
R-49		0.027	0.020
R-60		0.025	0.017
<b>Scissors Truss</b>			
R-30 (4/12 roof pitch)		0.043	0.031
R-38 (4/12 roof pitch)		0.040	0.025
R-49 (4/12 roof pitch)		0.038	0.020
R-30 (5/12 roof pitch)		0.039	0.032
R-38 (5/12 roof pitch)		0.035	0.026
R-49 (5/12 roof pitch)		0.032	0.020
<b>Vaulted Ceilings</b>			
		<b>16" O.C.</b>	<b>24" O.C.</b>
<b>Vented</b>			
R-19	2x10 joist	0.049	0.048
R-30	2x12 joist	0.034	0.033
R-38	2x14 joist	0.027	0.027
<b>Unvented</b>			
R-30	2x10 joist	0.034	0.033
R-38	2x12 joist	0.029	0.027
R-21 + R-21	2x12 joist	0.026	0.025
<b>Roof Deck</b>			
		<b>4x Beams, 48" O.C.</b>	
R-12.5	2" Rigid insulation	0.064	
R-21.9	3.5" Rigid insulation	0.040	
R-37.5	6" Rigid insulation	0.025	
R-50	8" Rigid insulation	0.019	

**Table 10-7A  
Steel Truss<sup>1</sup> Framed Ceiling  $U_o$**

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.1075	0.0991	0.0928	0.0878	0.0839	0.0807	0.0780	0.0757	0.0737	0.0720	0.0706	0.0693	0.0681
30	0.0907	0.0823	0.0760	0.0710	0.0671	0.0638	0.0612	0.0589	0.0569	0.0552	0.0538	0.0525	0.0513
38	0.0844	0.0759	0.0696	0.0647	0.0607	0.0575	0.0548	0.0525	0.0506	0.0489	0.0474	0.0461	0.0449
49	0.0789	0.0704	0.0641	0.0592	0.0552	0.0520	0.0493	0.0470	0.0451	0.0434	0.0419	0.0406	0.0395

**Table 10-7B**  
Steel Truss<sup>1</sup> Framed Ceiling U<sub>o</sub> with R-3 Sheathing<sup>2</sup>

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0809	0.0763	0.0728	0.0701	0.0679	0.0661	0.0647	0.0634	0.0623	0.0614	0.0606	0.0599	0.0592
30	0.0641	0.0595	0.0560	0.0533	0.0511	0.0493	0.0478	0.0466	0.0455	0.0446	0.0438	0.0431	0.0424
38	0.0577	0.0531	0.0496	0.0469	0.0447	0.0430	0.0415	0.0402	0.0392	0.0382	0.0374	0.0367	0.0361
49	0.0523	0.0476	0.0441	0.0414	0.0393	0.0375	0.0360	0.0348	0.0337	0.0328	0.0319	0.0312	0.0306

**Table 10-7C**  
Steel Truss<sup>1</sup> Framed Ceiling U<sub>o</sub> with R-5 Sheathing<sup>2</sup>

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0732	0.0697	0.0670	0.0649	0.0633	0.0619	0.0608	0.0598	0.0590	0.0583	0.0577	0.0571	0.0567
30	0.0564	0.0529	0.0502	0.0481	0.0465	0.0451	0.0440	0.0430	0.0422	0.0415	0.0409	0.0403	0.0399
38	0.0501	0.0465	0.0438	0.0418	0.0401	0.0388	0.0376	0.0367	0.0359	0.0351	0.0345	0.0340	0.0335
49	0.0446	0.0410	0.0384	0.0363	0.0346	0.0333	0.0322	0.0312	0.0304	0.0297	0.0291	0.0285	0.0280

**Table 10-7D**  
Steel Truss<sup>1</sup> Framed Ceiling U<sub>o</sub> with R-10 Sheathing<sup>2</sup>

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0626	0.0606	0.0590	0.0578	0.0569	0.0561	0.0555	0.0549	0.0545	0.0541	0.0537	0.0534	0.0531
30	0.0458	0.0437	0.0422	0.0410	0.0401	0.0393	0.0387	0.0381	0.0377	0.0373	0.0369	0.0366	0.0363
38	0.0394	0.0374	0.0359	0.0347	0.0337	0.0330	0.0323	0.0318	0.0313	0.0309	0.0305	0.0302	0.0299
49	0.0339	0.0319	0.0304	0.0292	0.0283	0.0275	0.0268	0.0263	0.0258	0.0254	0.0251	0.0247	0.0245

**Table 10-7E**  
Steel Truss<sup>1</sup> Framed Ceiling U<sub>o</sub> with R-15 Sheathing<sup>2</sup>

Cavity R-value	Truss Span (ft)												
	12	14	16	18	20	22	24	26	28	30	32	34	36
19	0.0561	0.0550	0.0541	0.0535	0.0530	0.0526	0.0522	0.0519	0.0517	0.0515	0.0513	0.0511	0.0509
30	0.0393	0.0382	0.0373	0.0367	0.0362	0.0358	0.0354	0.0351	0.0349	0.0347	0.0345	0.0343	0.0341
38	0.0329	0.0318	0.0310	0.0303	0.0298	0.0294	0.0291	0.0288	0.0285	0.0283	0.0281	0.0279	0.0278
49	0.0274	0.0263	0.0255	0.0249	0.0244	0.0239	0.0236	0.0233	0.0230	0.0228	0.0226	0.0225	0.0223

1 - Assembly values based on 24 inch on center truss spacing; 11 Truss member connections penetrating insulation (4 at the eaves, 7 in the interior space); ½ inch drywall ceiling; all truss members are 2x4 "C" channels with a solid web.  
2 - Ceiling sheathing installed between bottom chord and drywall.

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

**WAC 51-11-1008 Section 1008 Air infiltration.**

1008.1 General: Tables 10-8 and ((10-9)) 10-8A list effective air change rates and heat capacities for heat loss due to infiltration for Group R occupancy.

Estimated seasonal average infiltration rate in air changes per hour (ACH) is given for standard air-leakage control (see section 502.4 of this code for air leakage requirements for Group R occupancy). The effective air-change rate shall be used in

calculations for compliance under either the Component Performance or Systems Analysis approaches.

Heat loss due to infiltration shall be computed using the following equation:

$$Q_{\text{infil}} = \text{ACH}_{\text{eff}} * \text{HCP}$$

where:  $Q_{\text{infil}}$  = Heat loss due to air infiltration

$\text{ACH}_{\text{eff}}$  = the effective air infiltration rate in Table 10-8

HCP = the Heat Capacity Density Product for the appropriate elevation or climate zone as given below.

**TABLE 10-8  
ASSUMED EFFECTIVE AIR CHANGES  
PER HOUR**

Air-Leakage Control Package	Air Changes per Hour	
	<u>Natural</u>	<u>Effective</u>
Standard	0.35	0.35

**TABLE ((10-9)) 10-8A  
DEFAULT HEAT CAPACITY/DENSITY PRODUCT FOR AIR**

Zone	Average Elevation	Heat Capacity/Density
1	Mean Sea Level	0.0180 Btu/h•°F
2	2000	0.0168 Btu/h•°F
3	3000	0.0162 Btu/h•°F

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

**WAC 51-11-1009 Section 1009 Mass.**

1009.1 General: ((Table)) Tables 10-9 and 10-10 list((s)) default ((mass-values)) mass values for ((residential)) concrete masonry construction ((types)). ((All)) Calculations are based on standard ASHRAE values for heat-storage capacity as listed in

Standard ((RS-1)) RS-27, Chapter 24.

Thermal capacity of furniture is ignored, as is heat storage beyond the first four inches of mass thickness. All mass is assumed to be in direct contact with the conditioned space. Concrete separated from the heated volume by other materials must multiply the listed concrete mass value by the result of the following formula:

$$\text{Ln}(\text{R-value}) \times (-.221) + 0.5$$

Where:

Ln= Natural log

R-value= R-value of material covering concrete

Note: All default values for covered concrete slabs have been adjusted according to this procedure.

1009.2 Mass Description: Mass is divided into two types: Structural and additional.

Structural Mass: Includes heat-storage capacity of all standard building components of a typical residential structure, including floors, ceilings, and interior and exterior walls in Btu/ft<sup>2</sup>•°F of floor area. It also assumes exterior wall, interior wall and ceiling surface area approximately equals three times the floor area.

Additional Mass: Includes any additional building material not part of the normal structure, which is added specifically to increase the building's thermal-storage capability. This category includes masonry fireplaces, water or trombe walls, and extra layers of sheetrock. Coefficients are in Btu/ft<sup>2</sup>•°F of surface area of material exposed to conditioned space. The coefficient for water is Btu/°F•gallon.

1009.3 Component Description: Light frame assumes one inch thick wood flooring with five-eighths inch sheetrock on ceilings and interior walls, and walls consisting of either five-eighths inch sheetrock or solid logs. Slab assumes a four-inch concrete slab on or below grade, with five-eighths inch sheetrock on exterior and interior walls and ceiling, and with separate values for interior or exterior wall insulation. Adjustments for slab covering is based on R-value of material. Additional mass values are based on the density multiplied by the specific heat of the material adjusted for listed thickness.

**TABLE 10-9**  
**HEAT CAPACITY**

	<u>Partial Grout</u>	<u>Solid Grout</u>
<u>8" CMU</u>	<u>9.65</u>	<u>15.0</u>
<u>12" CMU</u>	<u>14.5</u>	<u>23.6</u>
<u>8" Brick</u>	<u>10.9</u>	<u>16.4</u>
<u>6" Concrete</u>	<u>NA</u>	<u>14.4</u>

**TABLE 10-10**  
**DEFAULT MASS VALUES**

Structural Mass M-value	Btu/ft <sup>2</sup> •°F floor area
<b>Light Frame:</b>	
Joisted/post & beam floor, sheetrock walls and ceilings	3.0
Joisted/post & beam floor, log walls, sheetrock ceilings	4.0
<b>Slab With Interior Wall Insulation:</b>	
Slab, no covering or tile, sheetrock walls and ceilings	10.0
Slab, hardwood floor covering, sheetrock walls and ceilings	7.0
Slab, carpet and pad, sheetrock walls and ceilings	5.0
<b>Slab With Exterior Wall Insulation:</b>	
Slab, no covering or tile, sheetrock walls and ceilings	12.0
Slab, hardwood floor covering, sheetrock walls and ceilings	9.0
Slab, carpet and pad, sheetrock walls and ceilings	7.0
<b>Additional Mass M-Value:</b>	
	<b>Btu/ft<sup>2</sup>•°F surface area</b>
Gypsum wallboard, 1/2 inch thickness	0.54
Gypsum wallboard, 5/8 inch thickness	0.68
Hardwood floor	1.40
Concrete/Brick, 4 inch-thickness	10.30
Concrete/Brick, 6 inch-thickness	15.40
	<b>Btu/°F•gallon</b>
Water, 1 gallon	8.0

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

**WAC 51-11-1132 Alterations and repairs.** Alterations and repairs to buildings or portions thereof originally constructed subject to the requirements of this Code shall conform to the provisions of this Code without the use of the exception in Section 1130. Other alterations and repairs may be made to existing buildings and moved buildings without making the entire building comply with all of the requirements of this Code for new buildings, provided the following requirements are met:

1132.1 Building Envelope: Alterations or repairs shall comply with nominal R-values and glazing requirements in Table 13-1 or 13-2.

EXCEPTIONS:

1. Storm windows installed over existing glazing.
2. Glass replaced in existing sash and frame provided that glazing is of equal or lower U-factor.
3. For solar heat gain coefficient compliance, glazing with a solar heat gain coefficient equal to or lower than that of the other existing glazing.
4. Existing roof/ceiling, wall or floor cavities exposed during construction provided that these cavities are insulated to full depth with insulation having a minimum nominal value of R-3.0 per inch installed per Sections 1311 and 1313.
5. Existing walls and floors without framing cavities, provided that any new cavities added to existing walls and floors comply with Exception 4.
6. Existing roofs where the roof membrane is being replaced and
  - a. The roof sheathing or roof insulation is not exposed; or
  - b. If there is existing roof insulation below the deck.

In no case shall the energy efficiency of the building be decreased.

1132.2 Building Mechanical Systems: Those parts of systems which are altered or replaced shall comply with Chapter 14 of this Code.

1132.3 Lighting and Motors: Tenant improvements, alterations or repairs where 60 percent or more of the fixtures in a use (as defined in Table 15-1) within a tenant space or in an entire floor (whichever is smaller) are new shall comply with Sections 1531 and 1532. Where less than 60 percent of the fixtures are new, the installed lighting wattage shall be maintained or reduced. Where 60 percent or more of the lighting fixtures in a suspended ceiling are new, and the existing insulation is on the suspended ceiling, the roof/ceiling assembly shall be insulated according to the provisions of Chapter 13 Section 1311.2.

Where new wiring is being installed to serve added fixtures and/or fixtures are being relocated to a new circuit, controls shall comply with Sections 1513.1 through 1513.5. Where a new lighting panel (or a moved lighting panel) with all new raceway and conductor wiring from the panel to the fixtures is being installed, controls shall comply with Section 1513.6.

Those motors which are altered or replaced shall comply with Section 1511.

## CHAPTER 12 DEFINITIONS

Note: For nonresidential definitions, see Chapter 2.

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

**WAC 51-11-1312 Glazing and doors.**

1312.1 Standard Procedure for Determination of Glazing and Door U-Factors: U-Factors for glazing and doors shall be determined, certified and labeled in accordance with Standard RS-31 by a certified independent agency licensed by the National Fenestration Rating Council (NFRC). Compliance shall be based on the Residential or the Nonresidential Model Size. Product samples used for U-factor determinations shall be production line units or representative of units as purchased by the consumer or contractor. Unlabeled glazing and doors shall be assigned the default U-factor in (~~Section 2006~~) Table 10-6.

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

EXCEPTION: Shading coefficients (SC) shall be an acceptable alternate for compliance with solar heat gain coefficient requirements. Shading coefficients for glazing shall be taken from Chapter 29 of RS-27 or from the manufacturer's test data.

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

**WAC 51-11-1313 Moisture control.**

1313.1 Vapor Retarders: Vapor retarders shall be installed on the warm side (in winter) of insulation as required by this section.

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

1313.2 Roof/Ceiling Assemblies: Roof/ceiling assemblies where the ventilation space above the insulation is less than an average of twelve inches shall be provided with a vapor retarder. (For enclosed attics and enclosed rafter spaces see Section 1505.3 of the Washington State Building Code.) Roof/ceiling assemblies without a vented airspace, allowed only where neither the roof deck nor the roof structure are made of wood, shall provide a continuous vapor retarder with taped seams.

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

1313.3 Walls: Walls separating conditioned space from unconditioned space shall be provided with a vapor retarder.

1313.4 Floors: Floors separating conditioned space from unconditioned space shall be provided with a vapor retarder.

1313.5 Crawl Spaces: 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 twelve 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 three and one-half inches.

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

**WAC 51-11-1322 Opaque envelope.** Roof/ceilings, opaque exterior walls, opaque doors, floors over unconditioned space, below grade walls, slab on grade floors, and radiant floors enclosing conditioned spaces shall be insulated according to Section 1311 and Tables 13-1 or 13-2. Compliance with nominal R-values shall be demonstrated for the thermal resistance of the added insulation in framing cavities and/or insulated sheathing only. Nominal R-values shall not include the thermal transmittance of other building materials or air films.

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

EXCEPTIONS:

1. Opaque smoke vents are not required to meet insulation requirements.
2. The perimeter edge of an above grade floor slab which penetrates the exterior wall may be left uninsulated provided that the wall insulation is increased by R-2 above that required in Tables 13-1 and 13-2.

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

**WAC 51-11-1323 Glazing.** Glazing shall comply with Section 1312 and Tables 13-1 or 13-2. All glazing shall be, at a minimum, double glazing.

EXCEPTIONS:

1. Vertical glazing located on the display side of the street level story of a retail occupancy provided the glazing (~~is double-glazed with a minimum 1/2 inch airspace and~~) is double-glazed with a minimum 1/2 inch airspace and with a low-e coating having a maximum emittance of e-0.40 or has an area weighted U-factor of 0.60 or less. (When this exception is used, there are no SHGC requirements) and,
  - a. does not exceed 75 percent of the gross exterior wall area of the (~~street level story which does not exceed 20 feet in height~~) display side of the street level story. However, if the display side of the street level story exceeds 20 feet in height, then this exception may only be used for the first 20 feet of that story.
  - b.

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

2. Single glazing for ornamental, security, or architectural purposes shall be included in the percentage of the total glazing area, U-factor calculation and SHGC as allowed in the Tables 13-1 or 13-2. The maximum area allowed for the total of all single glazing is one percent of the gross exterior wall floor area.

1323.1 Area: The percentage of total glazing (vertical and overhead) area relative to the gross exterior wall area shall not be greater than the appropriate value from Tables 13-1 or 13-2 for the vertical glazing U-factor, overhead glazing U-factor and solar heat gain coefficient selected.

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

1323.3 Solar Heat Gain Coefficient: The area-weighted average solar heat gain coefficient of all glazing shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and U-factor.

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

**WAC 51-11-1331 General.** Buildings or structures whose design heat loss rate ( $UA_p$ ) and solar heat gain coefficient rate ( $SHGC \cdot A_p$ ) are less than or equal to the target heat loss rate ( $UA_t$ ) and solar heat gain coefficient rate ( $SHGC \cdot A_t$ ) shall be considered in compliance with this section. The stated U-factor, F-factor or allowable area of any component assembly, listed in Tables 13-1 or 13-2, such as roof/ceiling, opaque wall, opaque door, glazing, floor over conditioned space, slab on grade floor, radiant floor or opaque floor may be increased and the U-factor or F-factor for other components decreased, provided that the total heat gain or loss for the entire building envelope does not exceed the total resulting from compliance to the U-factors, F-factors or allowable areas specified in this section.

EXCEPTION: For buildings or structures utilizing the other space heat type (including heat pumps and VAV) compliance path, for the gross opaque wall, opaque door and glazing (vertical and overhead) area only, compliance may also be shown using the ENVSTD diskette version 2.1 (~~or later of Standard RS-9~~) of ASHRAE/IESNA Standard 90.1-1989, or an approved alternative, with the following additional requirements:

1. Only the Exterior Wall Requirements portion of the ENVSTD computer program may be used under this exception.
2. Overhead glazing shall be added to vertical glazing, and shall be input as 1/4 north, 1/4 east, 1/4 south and 1/4 west facing.
3. Lighting loads shall be determined according to Table 15-1.
4. Equipment loads shall be determined from Table 3-1 of Standard RS-29.

**WAC 51-11-1334 Solar heat gain coefficient rate calculations.**

Solar heat gain coefficient shall comply with Section 1323.3. The target SHGCA<sub>t</sub> and the proposed SHGCA<sub>p</sub> shall be calculated using Equation 13-3 and 13-4 and the corresponding areas and SHGCs from Table 13-1 or 13-2.

**Equation 13-1:  
Target UA<sub>(t)</sub>**

$$UA_t = U_{rat}A_{rat} + U_{ograt}A_{ograt} + U_{ort}A_{ort} + U_{ogort}A_{ogort} + U_{wt}A_{wt} + U_{vgt}A_{vgt} + U_{dt}A_{dt} + U_{ft}A_{ft} + F_{st}P_{st} + U_{bgwt}A_{bgwt}$$

UA<sub>t</sub> = The target combined specific heat transfer of the gross roof/ceiling assembly, exterior wall and floor area.

Where:

- U<sub>rat</sub> = The thermal transmittance value for roofs over attics found in Table 13-1 or 13-2.
- U<sub>ograt</sub> = The thermal transmittance for overhead glazing found in Table 13-1 or 13-2 which corresponds to the proposed total glazing area as a percent of gross exterior wall area.
- U<sub>ort</sub> = The thermal transmittance value for other roofs found in Table 13-1 or 13-2.
- U<sub>ogort</sub> = The thermal transmittance for overhead glazing found in Table 13-1 or 13-2 which corresponds to the proposed total glazing area as a percent of gross exterior wall area.
- U<sub>wt</sub> = The thermal transmittance value for opaque walls found in Table 13-1 or 13-2.
- U<sub>vgt</sub> = The thermal transmittance value for vertical glazing found in Table 13-1 or 13-2 which corresponds to the proposed total glazing area as a percent of gross exterior wall area.
- U<sub>dt</sub> = The thermal transmittance value for opaque doors found in Table 13-1 or 13-2.
- U<sub>ft</sub> = The thermal transmittance value for floors over unconditioned space found in Table 13-1 or 13-2.
- F<sub>st</sub> = The F-factor for slab-on-grade and radiant slab floors found in Table 13-1 or 13-2.
- U<sub>bgwt</sub> = The thermal transmittance value for opaque walls found in Table 13-1 or 13-2.
- A<sub>dt</sub> = The proposed opaque door area, A<sub>d</sub>.
- A<sub>ft</sub> = The proposed floor over unconditioned space area, A<sub>f</sub>.
- P<sub>st</sub> = The proposed lineal feet of slab-on-grade and radiant slab floor perimeter, P<sub>s</sub>.
- A<sub>bgwt</sub> = The proposed below grade wall area, A<sub>bgw</sub>.

**and;**

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

- A<sub>rat</sub> = The proposed roof over attic area, A<sub>ra</sub>.
- A<sub>ograt</sub> = The proposed overhead glazing area in roofs over attics, A<sub>ogra</sub>.
- A<sub>ort</sub> = The proposed other roof area, A<sub>or</sub>.

$A_{ogort}$  = The proposed overhead glazing area in other roofs,  $A_{ogort}$ .

$A_{wt}$  = The proposed opaque above grade wall area,  $A_w$ .

$A_{vgt}$  = The proposed vertical glazing area,  $A_{vg}$ .

or;

if the total amount of glazing area as a percent of gross exterior wall area exceeds the maximum allowed in Table 13-1 or 13-2:

$A_{rat}$  = The greater of:  
the proposed roof over attic area, and  
the gross roof over attic area minus  $A_{ograt}$ .

$A_{ograt}$  = The lesser of:  
proposed overhead glazing area in roofs over attics, and  
the maximum allowed glazing area from Table 13-1 or 13-2.

$A_{ort}$  = The greater of:  
the proposed other roof area, and  
the gross other roof area minus  $A_{ogort}$ .

$A_{ogort}$  = The lesser of:  
the proposed overhead glazing area in other roofs, and  
the maximum allowed glazing area from Table 13-1 or 13-2 minus  $A_{ograt}$ .

$A_{wt}$  = The greater of:  
proposed opaque above grade wall area, and  
the gross exterior above grade wall area minus  $A_{dt}$  minus  $A_{vgt}$ .

$A_{vgt}$  = The lesser of:  
the proposed vertical glazing area, and  
the maximum allowed glazing area from Table 13-1 or 13-2 minus  $A_{ograt}$  minus  $A_{ogort}$ .

### EQUATION 13-2

#### Proposed $UA_p$

$$UA_p = U_{ra}A_{ra} + U_{or}A_{or} + U_{og}A_{og} + U_wA_w + U_dA_d + U_{vg}A_{vg} + U_fA_f + F_sP_s + U_{bgw}A_{bgw}$$

Where:

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

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

$A_{ra}$  = Opaque roof over attic area.

$U_{or}$  = The thermal transmittance of the other roof area.

$A_{or}$  = Opaque other roof area.

$U_{og}$  = The thermal transmittance for the overhead glazing

$A_{og}$  = Overhead glazing area.

$U_w$  = The thermal transmittance of the opaque wall area.

$A_w$  = Opaque above grade wall area (not including opaque doors).

$U_{vg}$  = The thermal transmittance of the vertical glazing area.

$A_{vg}$  = Vertical glazing area.

- $U_d$  = The thermal transmittance value of the opaque door area.
- $A_d$  = Opaque door area.
- $U_f$  = The thermal transmittance of the floor over unconditioned space area.
- $A_f$  = Floor area over unconditioned space.
- $F_s$  = Slab-on-grade or radiant floor component F-factor.
- $P_s$  = Lineal feet of slab-on-grade or radiant floor perimeter.
- $U_{bgw}$  = The thermal transmittance value of the below grade wall area.
- $A_{bgw}$  = Below grade wall area as defined in Tables 13-1 or 13-2.

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

$$U_{w1}A_{w1} + U_{w2}A_{w2} + U_{w3}A_{w3} + \dots \text{etc.}$$

**EQUATION 13-3**

**Target SHGCA<sub>t</sub>**

$$SHGCA_t = SHGC_t (A_{ograt} + A_{ogort} + A_{vgt})$$

Where:

$SHGCA_t$  = The target combined specific heat gain of the target glazing area.

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

$A_{ograt}$ ,  $A_{ogort}$ , and  $A_{vgt}$  are defined under Equation 13-1.

**EQUATION 13-4**

**Proposed SHGCA<sub>p</sub>**

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

Where:

$SHGCA_p$  = The combined proposed specific heat gain of the proposed glazing area.

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

$A_{og}$  = The overhead glazing area.

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

$A_{vg}$  = The vertical glazing area.

**TABLE 13-1**

**BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 1  
MINIMUM INSULATION R-VALUES OR  
MAXIMUM COMPONENT U-FACTORS FOR ZONE 1**

**Building Components**

Space Heat Type	Components
-----------------	------------

	Roofs Over Attic	All Other Roofs	Opaque Walls <sup>1,2</sup>	Opaque Doors	Floor Over Uncond Space	Slab On Grade <sup>5</sup>
1. Electric resistance heat**	R-38 or U=0.031	R-30 or U=0.034	R-19 or U=0.062(( <sup>3</sup> ))	U=0.60	R-30 or U=0.029	R-10 or F=0.54
2. All others including Heat pumps and VAV	R-30 or U=0.036	R-21 or U=0.050	R-11 or U=0.14	U=0.60	R-19 or U=0.056	R-10 or F=0.54

\*\* Compliance with nominal prescriptive R-values requires wood framing.

**MAXIMUM GLAZING AREAS AND U-FACTORS AND  
MAXIMUM GLAZING SOLAR HEAT GAIN COEFFICIENTS  
FOR ZONE 1**

**Glazing**

Maximum Glazing Area as % of Wall	0% to 15%		>15% to 20%		>20% to 30%		>30% to 40%					
	Maximum U-Factor		Max. SHGC <sup>4</sup>	Maximum U-Factor		Max. SHGC <sup>4</sup>	Maximum U-Factor		Max. SHGC <sup>4</sup>			
	VG	OG		VG	OG		VG	OG				
1. Electric resistance heat	0.40	0.80	1.0	0.40	0.80	1.0	PRESCRIPTIVE PATH NOT ALLOWED					
2. All others including Heat pumps and VAV	0.90	1.45	1.0	0.75	1.40	1.0	0.60	1.30	0.65	0.50	1.25	0.45

**Footnotes**

- Below Grade Walls:**  
When complying by the prescriptive approach, Section 1322:  
 a) walls insulated on the interior shall use opaque wall values,  
 b) walls insulated on the exterior shall use a minimum of R-10 insulation,  
 c) those portions of below grade walls and footings that are more than 10 feet below grade, and not included in the gross exterior wall area, may be left uninsulated.  
  
 When complying by the component performance approach, Section 1331:  
 a) walls insulated on the interior shall use the opaque wall values when determining  $U_{bgwt}$ ,  
 b) walls insulated on the exterior shall use a target U-factor of  $U=0.070$  for  $U_{bgwt}$ ,  
 c) those portions of below grade walls and footings that are more than 10 feet below grade, and not included in the gross exterior wall area, need not be included when determining  $A_{bgwt}$  and  $A_{bgw}$ .
- Concrete Masonry Walls:** If the area weighted heat capacity of the total opaque above grade wall is a minimum of  $9.0 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$ , then the U-factor may be increased to 0.19 for interior insulation and 0.25 for integral and exterior insulation for insulation position as defined in Chapter ((2)) 2. Individual walls with heat capacities less than  $9.0 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$  and below grade walls shall meet opaque wall requirements listed above. Glazing shall comply with the following:

Maximum Glazing Area as % of Wall	0 to 10 %		>10 to 15 %		>15% to 20 %		>20% to 25 %					
	Maximum U-Factor		Max. SHGC <sup>4</sup>	Maximum U-Factor		Max. SHGC <sup>4</sup>	Maximum U-Factor		Max. SHGC <sup>4</sup>			
	VG	OG		VG	OG		VG	OG				
1. Electric resistance heat	0.40	0.80	1.0	0.40	0.80	1.0	0.40	0.80	1.0	NOT ALLOWED		
2. All others including Heat pumps and VAV	0.90	1.45	1.0	0.75	1.40	1.0	0.65	1.30	0.80	0.60	1.30	0.65

- (Metal Stud Walls:** For metal stud construction  $U=0.11$ )) Reserved.
- SHGC (Solar Heat Gain Coefficient per Section 1312.2):** May substitute Maximum Shading Coefficient (SC) for SHGC (See ((Section 1210)) Chapter 2 for definition of Shading Coefficient).
- Radiant Floors:** Where insulation is required under the entire slab, radiant floors shall use a minimum of R-10 insulation or  $F=0.55$  maximum. Where insulation is not required under the entire slab, radiant floors shall use R-10 perimeter insulation according to Section 1311.6 or  $F=0.78$  maximum.

**TABLE 13-2  
BUILDING ENVELOPE REQUIREMENTS**

**FOR CLIMATE ZONE 2**

**MINIMUM INSULATION R-VALUES OR  
MAXIMUM COMPONENT U-FACTORS FOR ZONE 2**

**Building Components**

Space Heat Type	Components					
	Roofs Over Attic	All Other Roofs	Opaque Walls <sup>1,2</sup>	Opaque Doors	Floor Over Uncond Space	Slab On Grade
1. Electric resistance heat**	R-38 or U=0.031	R-30 or U=0.034	R-24 or U=0.044(*)	U=0.60	R-30 or U=0.029	R-10 or F=0.54
2. All others including Heat pumps and VAV	R-38 or U=0.031	R-25 or U=0.040	R-19 or U=0.11	U=0.60	R-21 or U=0.047	R-10 or F=0.54

\*\* Compliance with nominal prescriptive R-values requires wood framing.

**MAXIMUM GLAZING AREAS AND U-FACTORS AND  
MAXIMUM GLAZING SOLAR HEAT GAIN COEFFICIENTS  
FOR ZONE 2**

**Glazing**

Maximum Glazing Area as % of Wall	0% to 15%		>15% to 20%		>20% to 25%		>25% to 30%					
	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		
	VG	OG		VG	OG		VG	OG		VG	OG	
1. Electric resistance heat	0.40	0.80	1.0	0.40	0.80	1.0	PRESCRIPTIVE PATH NOT ALLOWED					
2. All others including Heat pumps and VAV	0.90	1.45	1.0	0.75	1.40	1.0	0.60	1.30	0.60	0.50	1.25	0.50

**Footnotes**

- Below Grade Walls:**  
When complying by the prescriptive approach, Section 1322:  
 a) walls insulated on the interior shall use opaque wall values,  
 b) walls insulated on the exterior shall use a minimum of R-12 insulation,  
 c) those portions of below grade walls and footings that are more than 10 feet below grade, and not included in the gross exterior wall area, may be left uninsulated.  
  
 When complying by the component performance approach, Section 1331:  
 a) walls insulated on the interior shall use the opaque wall values when determining  $U_{bgwt}$ ,  
 b) walls insulated on the exterior shall use a target U-factor of  $U=0.061$  for  $U_{bgwt}$ ,  
 c) those portions of below grade walls and footings that are more than 10 feet below grade, and not included in the gross exterior wall area, need not be included when determining  $A_{bgwt}$  and  $A_{bgw}$ .
- Concrete Masonry Walls:** If the area weighted heat capacity of the total opaque above grade wall is a minimum of  $9.0 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$ , then the U-factor may be increased to 0.19 for interior insulation and 0.25 for integral and exterior insulation for insulation position as defined in Chapter ((12)) 2. Individual walls with heat capacities less than  $9.0 \text{ Btu/ft}^2 \cdot ^\circ\text{F}$  and below grade walls shall meet opaque wall requirements listed above. Glazing shall comply with the following:

Maximum Glazing Area as % of Wall	0 to 5 %			>5 to 7 %			>7% to 10 %			>10% to 15 %		
	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		Max. SHGC <sup>d</sup>	Maximum U-Factor		Max. SHGC <sup>d</sup>
	VG	OG		VG	OG		VG	OG		VG	OG	
1. Electric resistance heat	0.40	0.80	1.0	0.40	0.80	1.0	0.40	0.80	1.0	NOT ALLOWED		
2. All others including Heat pumps and VAV	0.90	1.45	1.0	0.60	1.30	0.70	0.50	1.25	0.50	0.40	0.80	0.40

- (Metal Stud Walls: For metal stud construction U=0.10.)** Reserved.
- SHGC (Solar Heat Gain Coefficient per Section 1312.2):** May substitute Maximum Shading Coefficient (SC) for SHGC (See ((Section

~~1210~~) Chapter 2 for definition of Shading Coefficient).

5. **Radiant Floors:** Where insulation is required under the entire slab, radiant floors shall use a minimum of R-10 insulation or F=0.55 maximum. Where insulation is not required under the entire slab, radiant floors shall use R-10 perimeter insulation according to Section 1311.6 or F=0.78 maximum.

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

**WAC 51-11-1410 General requirements.** The building mechanical system shall comply with Sections 1411 through (~~1415~~) 1416, Sections 1440 through (~~1442~~) 1443 and Sections 1450 through 1454, and with one of the following paths:

- a. Simple Systems (Packaged Unitary Equipment) Sections 1420 through 1424.
- b. Complex Systems Sections 1430 through (~~1438~~) 1439.
- c. Systems Analysis. See Section 1141.4.

FIGURE 14A  
Mechanical Systems Compliance Paths

Section Number	Subject	Simple Systems Path	Complex Systems Path	Systems Analysis Option
1410	General Requirements	X	X	X
1411	HVAC Equipment Performance Requirements	X	X	X
1412	Controls	X	X	X
1413	Air Economizers	X	X	X
1414	Ducting Systems	X	X	X
1415	Piping Systems	X	X	X
<u>1416</u>	<u>Completion Requirements</u>	<u>X</u>	<u>X</u>	<u>X</u>
1420	Simple Systems (Packaged Unitary Equipment)	X		
1421	System Type	X		
1422	Controls	X		
1423	Economizers	X		
1424	Separate Air Distribution Systems	X		
1430	Complex Systems		X	
1431	System Type		X	
1432	Controls		X	
1433	Economizers		X	
1434	Separate Air Distribution Systems		X	
1435	Simultaneous Heating and Cooling		X	
1436	Heat Recovery		X	
1437	Electric Motor Efficiency		X	
1438	Variable Flow Systems		X	
<u>1439</u>	<u>Exhaust Hoods</u>		<u>X</u>	

Section Number	Subject	Simple Systems Path	Complex Systems Path	Systems Analysis Option
RS-29	Systems Analysis			X
1440	Service Water Heating	X	X	X
1441	Water Heater Installation	X	X	X
1442	Shut Off Controls	X	X	X
1443	<u>Pipe Insulation</u>	<u>X</u>	<u>X</u>	<u>X</u>
1450	Heated Pools	X	X	X
1451	General	X	X	X
1452	Pool Water Heaters	X	X	X
1453	Controls	X	X	X
1454	Pool Covers	X	X	X

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

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

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 98-03-003, filed 1/8/98, effective 7/1/98)

**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 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.

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:

1. Boilers.
2. 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 WSR 98-03-003, filed 1/8/98, effective 7/1/98)

**WAC 51-11-1414 Ducting systems.**

1414.1 Sealing: Duct work which is designed to operate at pressures above 1/2 inch water column static pressure shall be sealed in accordance with Standard RS-18. Extent of sealing required is as follows:

1. Static pressure: 1/2 inch to 2 inches; seal transverse joints.
2. Static pressure: 2 inches to 3 inches; seal all transverse joints and longitudinal seams.
3. Static pressure: Above 3 inches; seal all transverse joints, longitudinal seams and duct wall penetrations.

Duct tape and other pressure sensitive tape shall not be used as the primary sealant where ducts are designed to operate at static pressures of 1 inch W.C. or greater.

1414.2 Insulation: Ducts and plenums that are constructed and function as part of the building envelope, by separating interior space from exterior space, shall meet all applicable requirements of Chapter 13. These requirements include insulation installation, moisture control, air leakage, and building envelope insulation levels. Unheated equipment rooms with combustion air louvers must be isolated from the conditioned space by insulating interior surfaces to a minimum of R-11 and any exterior envelope surfaces

per Chapter 13. Outside air ducts serving individual supply air units with less than 2,800 cfm of total supply air capacity shall be insulated to a minimum of R-7 and are not considered building envelope. Other outside air duct runs are considered building envelope until they,

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

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

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

EXCEPTIONS:

1. Within the HVAC equipment.
2. Exhaust air ducts not subject to condensation.
3. Exposed ductwork within a (~~space~~) zone that serves that (~~space only~~) zone.

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

**WAC 51-11-1415 Piping systems.**

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

EXCEPTION: Piping installed within unitary HVAC equipment.

Cold water pipes outside the conditioned space shall be insulated in accordance with the Washington State Plumbing Code (chapter (~~51-26~~) 51-46 WAC).

NEW SECTION

**WAC 51-11-1416 Completion requirements.**

1416.1 Drawings: Construction documents shall require that within 90 days after the date of system acceptance, record drawings of the actual installation be provided to the building owner. Record drawings shall include as a minimum the location and performance data on each piece of equipment, general configuration of duct and pipe distribution system, including sizes, and the terminal air and water design flow rates.

1416.2 Manuals: Construction documents shall require an operating manual and maintenance manual be provided to the building owner.

The manual shall be in accordance with industry accepted standards and shall include, at a minimum, the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Operation and maintenance manuals for each piece of equipment requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of at least one service agency.
4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field determined set points shall be permanently recorded on control drawings at control devices, or, for digital control systems, in programming comments.
5. A complete narrative of how each system is intended to operate including suggested set points.

#### 1416.3 System Balancing

1416.3.1 General: Construction documents shall require that all HVAC systems be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within 10% of design rates, except variable flow distribution systems need not be balanced upstream of the controlling device (for example, VAV box or control valve). Construction documents shall require a written balance report be provided to the owner.

1416.3.2 Air System Balancing: Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.

1416.3.3 Hydronic System Balancing: Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the ability to measure pressure across the pump, or test ports at each side of each pump.

- EXCEPTIONS:
1. Pumps with pump motors of 10 hp or less.
  2. When throttling results in no greater than 5% of the nameplate horsepower draw above that required if the impeller were trimmed.

#### 1416.4 Systems Commissioning

1416.4.1 Simple Systems: For simple systems, as defined in Section 1421, and for warehouses and semi-heated spaces, HVAC control systems shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they operate in accordance with approved plans and specifications. A complete report of test procedures and results shall be prepared and filed with the owner. Drawing notes shall require commissioning in

accordance with this paragraph.

1416.4.2 Other Systems: All other HVAC control systems, and other automatically controlled systems for which energy consumption, performance, or mode of operation are regulated by this code, shall be tested to ensure that control devices, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they operate in accordance with approved plans and specifications.

1416.4.2.1 Documentation: Drawing notes shall require commissioning in accordance with this section. Drawing notes may refer to specifications for further commissioning requirements. Plans and specifications shall require tests mandated by this section be performed and the results recorded. Plans and specifications shall require preparation of preliminary and final reports of test procedures and results as described in Section 1416.4.2.2. Plans and specifications shall identify the following for each test:

1. Equipment and systems to be tested, including the extent of sampling tests,
2. Functions to be tested (for example calibration, economizer control, etc.),
3. Conditions under which the test shall be performed (for example winter design conditions, full outside air, etc.),
4. Measurable criteria for acceptable performance.

1416.4.2.2 Commissioning Reports

1416.4.2.2.1 Preliminary Commissioning Report: A preliminary commissioning report of test procedures and results shall be prepared. The preliminary report shall identify:

1. Deficiencies found during testing required by this section which have not been corrected at the time of report preparation and the anticipated date of correction.
2. Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.
3. Climatic conditions required for performance of the deferred tests, and the anticipated date of each deferred test.

1416.4.2.2.2 Final Commissioning Report: A complete report of test procedures and results shall be prepared and filed with the owner.

1416.4.2.3 Acceptance: Buildings or portions thereof, required by this code to comply with this section, shall not be issued a final certificate of occupancy until such time that the building official determines that the preliminary commissioning report required by this section has been completed.

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

**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.

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 98-03-003, filed 1/8/98, effective 7/1/98)

**WAC 51-11-1433 Economizers.** Economizers meeting the requirements of Section 1413 shall be installed on the following systems:

- 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.

**WAC 51-11-1435 Simultaneous heating and cooling.** Systems which provide heating and cooling simultaneously to a zone are prohibited. Zone thermostatic and humidistatic controls shall be capable of operating in sequence the supply of heating and cooling energy to the zone. Such controls shall prevent:

- a. Reheating for temperature control.
- b. Recooling for temperature control.
- c. Mixing or simultaneous supply of air that has been previously mechanically heated and air that has been previously cooled, either by economizer systems (~~(, for all air in excess of that required by the Washington State Ventilation and Indoor Air Quality Code (WAC 51-13))~~) or by mechanical refrigeration.
- d. Other simultaneous operation of heating and cooling systems to the same zone.
- e. Reheating for humidity control.

EXCEPTIONS:

- (+ Variable air volume systems which have fan-powered terminal units on the perimeter zones controlled to utilize plenum heat prior to new energy being used for morning warm-up; and which, during periods of occupancy, are designed to reduce the air supply to each zone to a minimum before reheating, recooling, or mixing takes place. The minimum volume of air from the main supply duct shall be no greater than the minimum required to meet ventilation requirements of the Washington State Ventilation and Indoor Air Quality Code (WAC 51-13).
2. Zones having special pressurization relationships or cross-contamination requirements.
3. Where at least 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered or site solar energy source.
4. Zones where specific humidity levels are required.
5. Zones with a peak supply air quantity of 300 cfm or less:)
1. Zones for which the volume of air that is reheated, recooled, or mixed is no greater than the larger of the following:
  - i. The volume of air required to meet the ventilation requirements of the Washington State Ventilation and Indoor Air Quality Code for the zone.
  - ii. 0.4 cfm/ft<sup>2</sup> of the zone conditioned floor area, provided that the temperature of the primary system air is, by design or through reset controls, 0-12°F below the design space heating temperature when outside air temperatures are below 60°F for reheat systems and the cold deck of mixing systems and 0-12°F above design space temperature when outside air temperatures are above 60°F for recooling systems and the hot deck of mixing systems. For multiple zone systems, each zone need not comply with this exception provided the average of all zones served by the system that have both heating and cooling ability comply.
  - iii. 300 cfm. This exception is for zones whose peak flow rate totals no more than 10% of the total fan system flow rate.
  - iv. Any higher rate that can be demonstrated, to the satisfaction of the building official, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in outdoor air intake in accordance with the multiple space requirements defined in ASHRAE Standard 62.
2. Zones where special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates are such that variable air volume systems are impractical.
3. Zones where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered (including condenser heat) or site solar energy source.
4. Zones where specific humidity levels are required to satisfy process needs, such as computer rooms, museums, surgical suites, and buildings with refrigerating systems, such as supermarkets, refrigerated warehouses, and ice arenas.

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

**WAC 51-11-1438 Variable flow systems.** For fans and pumps greater than 10 horsepower, where the application involves variable flow, there shall be variable ((frequency)) speed drives or variable flow devices installed. Acceptable variable flow devices include variable inlet vanes, variable blade pitch, and variable fan geometry. Throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.

NEW SECTION

**WAC 51-11-1439 Exhaust hoods.**

**1439.1 Kitchen Hoods.** Individual kitchen exhaust hoods larger than 5000 cfm shall be provided with make-up air sized so that at least 50% of exhaust air volume be (a) unheated or heated to no more than 60°F and (b) uncooled or cooled without the use of mechanical cooling.

EXCEPTIONS:

1. Where hoods are used to exhaust ventilation air which would otherwise exfiltrate or be exhausted by other fan systems.
2. Certified grease extractor hoods that require a face velocity no greater than 60 fpm.

**1439.2 Fume Hoods.** Each fume hood in buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm shall include at least one of the following features:

(a) Variable air volume hood exhaust and room supply systems capable of reducing exhaust and make-up air volume to 50% or less of design values.

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

(c) Heat recovery systems to precondition make-up air in accordance with Section 1436, without using any exception.

(d) Constant volume fume hood designed and installed to operate at less than 50 fpm face velocity.

NEW SECTION

**WAC 51-11-1443 Pipe insulation.** Piping shall be thermally insulated in accordance with Section 1415.1.

**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 <sup>1</sup> Cooling Capacity	Air Conditioners	8.5 EER	7.5 IPLV	ARI 360  -1986
		Heat Pumps	8.5 EER	7.5 IPLV	
>760,000 Btu/h <sup>1</sup> Cooling Capacity	Air Conditioners	8.2 EER	7.5 IPLV		
	Heat Pumps	8.7 EER	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) <sup>3</sup> EER 95°F	12.2 - (0.20 x Cap/1000) <sup>2,3</sup> 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) <sup>3</sup> ((EER)+(COP)) 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 <sub>t</sub> <sup>4</sup>	78% AFUE <sup>5</sup>	DOE 10 CFR Part430 AppN
	≥225,000 Btu/h	Gas, Max Rating <sup>6</sup> Gas, Min Rating <sup>6</sup>	80% E <sub>t</sub> <sup>4</sup> 78% E <sub>t</sub> <sup>4</sup>	NA NA	ANSI Z21.47 -1983
	≥225,000 Btu/h	Oil, Max Rating <sup>6</sup> Oil, Min Rating <sup>6</sup>	81% E <sub>t</sub> <sup>4</sup> 81% E <sub>t</sub> <sup>4</sup>	NA NA	UL 727 -1986
Warm-Air Duct Furnaces and Unit Heaters	All Size Gas Duct Furnaces	Max Rated Capacity <sup>6</sup>	78% E <sub>t</sub> <sup>4</sup>	NA	ANSI Z83.9
		Min Rated Capacity <sup>6</sup>	75% E <sub>t</sub> <sup>4</sup>	NA	-1986
	All Size Gas Unit Heaters	Max Rated Capacity <sup>6</sup>	78% E <sub>t</sub> <sup>4</sup>	NA	ANSI Z83.8
		Min Rated Capacity <sup>6</sup>	74% E <sub>t</sub> <sup>4</sup>	NA	-1985
All Size Oil Unit Heaters	Max Rated Capacity <sup>6</sup>	81% E <sub>t</sub> <sup>4</sup>	NA	UL 731	
	Min Rated Capacity <sup>6</sup>	81% E <sub>t</sub> <sup>4</sup>	NA	-1988	

- For units that have a heating section, deduct 0.2 from all required EER's and IPLV's.
- 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.
- 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.
- 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 <sup>1</sup> :	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	CTI 201 -1986
Water Source Heat Pump Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> : Entering Water[:]	9.3 EER 85°F ewt <sup>2</sup>	10.2 EER 75°F ewt <sup>2</sup>	ARI 320 -1986
	>65,000 and ≤135,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> : Entering Water[:]	10.5 EER 85°F ewt <sup>2</sup>	NA	CTI 201 -1986
Ground Water Heat Pump Cooling Ratings	<135,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> : Entering Water[:]	11.0 EER 70°F ewt <sup>2</sup>	11.5 EER 50°F ewt <sup>2</sup>	ARI 325 -1985
Water Cooled Unitary Air Conditioners Cooling Ratings	≤65,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> : Entering Water[:]	9.3 EER 85°F ewt <sup>2</sup>	8.3 IPLV 75°F ewt <sup>2</sup>	ARI 210/240 -1989
	>65,000 and ≤135,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> : Entering Water[:]	10.5 EER 85°F ewt <sup>2</sup>	NA	CTI 201 -1986
Water/Evap Cooled Air Cond. and Heat Pumps Cooling Ratings	>135,000 Btu/h Cooling Capacity	Standard Conditions <sup>1</sup> :	9.6 EER	9.0 IPLV	ARI 360 -1986 CTI 201 -1986
Air and Water/Evap Cooled Condensing Units Cooling Ratings <sup>3</sup>	>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	CTI 201 -1986
Air and Water Cooled Water Chilling Packages Cooling Ratings	<150 Tons	Water Cooled	3.8 COP	3.9 IPLV	ARI 550-90
	≥150 and <300 Tons		4.2 COP	4.5 IPLV	ARI 590-86pN
	≥300 Tons		5.2 COP <sup>4</sup>	5.3 IPLV <sup>4</sup>	CTI 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 <sup>1</sup> :	3.8 COP 70°F ewt <sup>2</sup>	NA NA	ARI 320 -1986
		Ground Water Source Standard Conditions <sup>1</sup> :	3.4 COP 70°F ewt <sup>2</sup>	3.0 COP 50°F ewt <sup>2</sup>	ARI 325 -1985

1. Standard Indoor Conditions: 80°F dry bulb and 67°F wet bulb.
2. ewt: Entering Water Temperature for water cooled heat pumps and air conditioners.
3. Condensing unit requirements are based on single - 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% <sup>1,3</sup>
	Oil-Fired <300,000 Btu/h	Seasonal Rating	AFUE 80% <sup>1</sup>

Reference	Category	Rating Condition	Minimum Performance
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 <sup>2</sup> Steady-State	$E_c^4$ 80%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	$E_c^4$ 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 <sup>2</sup> Steady-State	$E_c^4$ 83%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	$E_c^4$ 83%
H.I. Htg. Boiler Std. 86  ASME PTC4.1-64	Oil-Fired (Residual)  ≥300,000 Btu/h	1. Max. Rated Capacity <sup>2</sup> Steady-State	$E_c^4$ 83%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	$E_c^4$ 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 14-4**  
**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
200.0	94.5	95.0	94.5	95.0	95.0	95.0

**TABLE 14-5**

## Duct Insulation

Duct Type	Duct ((Insulation)) 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 ((both supply and return ducts)) 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)<sup>1</sup>**

Fluid Design Operating Temp. Range, °F	Insulation Conductivity		Nominal Pipe Diameter (in.)					
	Conductivity Range Btu • in. / (h • ft <sup>2</sup> • °F)	Mean Rating Temp. °F	Runouts <sup>2</sup> 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 • ft<sup>2</sup> • °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 • ft<sup>2</sup> • °F)

k= the lower value of the conductivity range listed in Table 14-6 for the applicable fluid temperature

range, Btu • in.]/(h • ft<sup>2</sup> • °F)

2. Runouts to individual terminal units not exceeding 12 ft. in length.

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

**WAC 51-11-1512 Exempt lighting.**

1512.1 Exempt Spaces: The following rooms, spaces, and areas, are exempt from the lighting power requirements in Sections 1520 and 1530 but shall comply with all other requirements of this chapter.

1. Areas in which medical or dental tasks are performed.
2. High risk security areas or any area identified by building officials as requiring additional lighting.
3. Spaces designed for primary use by the visually impaired, hard of hearing (lip-reading) or by senior citizens.
4. Food preparation areas.
5. Outdoor manufacturing, greenhouses, and processing areas.
6. Electrical/mechanical equipment rooms.
7. Outdoor athletic facilities.
8. Inspection and restoration areas in galleries and museums.
9. The sanctuary portion of a house of worship, defined as the space or room where the worship service takes place. Classrooms, meeting rooms, offices and multipurpose rooms that are part of the same facility are not exempt.

1512.2 Exempt Lighting Equipment: The following lighting equipment and tasks are exempt from the lighting requirements of Section 1520 and need not be included when calculating the installed lighting power under Section 1530 but shall comply with all other requirements of this chapter. All other lighting in areas that are not exempted by Section 1512.2, where exempt tasks and equipment are used, shall comply with all of the requirements of this chapter.

1. Special lighting needs for research.
2. Emergency lighting that is automatically OFF during normal building operation.
3. Lighting integral to signs, and permanently ballasted lighting fixtures for walkways and pathways.
4. Lighting that is part of machines, equipment or furniture.
5. Lighting that is used solely for indoor plant growth during the hours of 10:00 p.m. to 6:00 a.m.
6. Lighting for theatrical productions, television broadcasting (including sports facilities), audio-visual presentations, and special effects lighting for stage

- areas and dance floors in entertainment facilities.
7. Lighting for art exhibits, non-retail displays, portable plug in display fixtures, and show case lighting.
  8. Exterior lighting for public monuments.

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

**WAC 51-11-1513 Lighting controls.** Lighting, including exempt lighting in Section 1512, shall comply with this section. Where occupancy sensors are cited, they shall have the features listed in Section 1513.6.1. Where automatic time switches are cited, they shall have the features listed in Section 1513.6.2.

1513.1 Local Control and Accessibility: Each space, enclosed by walls or ceiling-height partitions, shall be provided with lighting controls located within that space. The lighting controls, whether one or more, shall be capable of turning off all lights within the space. The controls shall be readily accessible, at the point of entry/exit, to personnel occupying or using the space.

EXCEPTIONS: The following lighting controls may be centralized in remote locations:

1. Lighting controls for spaces which must be used as a whole.
2. Automatic controls.
3. Controls requiring trained operators.
4. Controls for safety hazards and security.

1513.2 Area Controls: The maximum lighting power that may be controlled from a single switch or automatic control shall not exceed that which is provided by a twenty ampere circuit loaded to not more than eighty percent. A master control may be installed provided the individual switches retain their capability to function independently. Circuit breakers may not be used as the sole means of switching.

EXCEPTIONS:

1. Industrial or manufacturing process areas, as may be required for production.
2. Areas less than five percent of footprint for footprints over 100,000 square feet.

1513.3 Daylight Zone Control: All daylighted zones, as defined in Chapter ((12)) 2, both under overhead glazing and adjacent to vertical glazing, shall be provided with individual controls, or daylight-or occupant-sensing automatic controls, which control the lights independent of general area lighting.

Contiguous daylight zones adjacent to vertical glazing are allowed to be controlled by a single controlling device provided that they do not include zones facing more than two adjacent cardinal orientations (i.e. north, east, south, west). Daylight zones under overhead glazing more than 15 feet from the perimeter shall be controlled separately from daylight zones adjacent to vertical glazing.

EXCEPTION: Daylight spaces enclosed by walls or ceiling height partitions and containing 2 or fewer light fixtures are not

required to have a separate switch for general area lighting.

1513.4 Display, Exhibition, and Specialty Lighting Controls: All display, exhibition, or specialty lighting shall be controlled independently of general area lighting.

1513.5 Automatic Shut-Off Controls, Exterior: Exterior lighting not intended for 24-hour continuous use shall be automatically switched by timer, photocell, or a combination of timer and photocell. Automatic time switches must also have program back-up capabilities, which prevent the loss of program and time settings for at least 10 hours, if power is interrupted.

1513.6 Automatic Shut-Off Controls, Interior: Office buildings greater than ((25,000)) 5,000 sq. ft. and all school classrooms shall be equipped with separate automatic controls to shut off the lighting during unoccupied hours. Automatic controls may be an occupancy sensor, time switch, or other device capable of automatically shutting off lighting.

EXCEPTIONS:

1. Areas that must be continuously illuminated, or illuminated in a manner requiring manual operation of the lighting.
2. Emergency lighting systems.
3. Switching for industrial or manufacturing process facilities as may be required for production.

1513.6.1 Occupancy Sensors: Occupancy sensors shall be capable of automatically turning off all the lights in an area, no more than 30 minutes after the area has been vacated.

1513.6.2 Automatic Time Switches: Automatic time switches shall have a minimum 7 day clock and be capable of being set for 7 different day types per week and incorporate an automatic holiday "shut-off" feature, which turns off all loads for at least 24 hours and then resumes normally scheduled operations. Automatic time switches shall also have program back-up capabilities, which prevent the loss of program and time settings for at least 10 hours, if power is interrupted.

Automatic time switches shall incorporate an over-ride switching device which:

- a. is readily accessible;
- b. is located so that a person using the device can see the lights or the areas controlled by the switch, or so that the area being illuminated is annunciated; and
- c. is manually operated;
- d. allows the lighting to remain on for no more than two hours when an over-ride is initiated; and
- e. controls an area not exceeding 5,000 square feet or 5 percent of footprint for footprints over 100,000 square feet, whichever is greater.

1513.7 Commissioning Requirements: For lighting controls which include daylight or occupant sensing automatic controls, automatic shut-off controls, occupancy sensors, or automatic time switches, the lighting controls shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications. Sequences of operation shall be functionally tested to ensure they

operate in accordance with approved plans and specifications. A complete report of test procedures and results shall be prepared and filed with the owner. Drawing notes shall require commissioning in accordance with this paragraph.

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

**WAC 51-11-1521 Prescriptive interior lighting requirements.**

Spaces for which the Unit Lighting Power Allowance in Table 15-1 is 0.8 watts per square foot or greater may use unlimited numbers of lighting fixtures and lighting energy, provided that the installed lighting fixtures (~~are~~) comply with all four of the following criteria:

- a. one- or two-lamp (but not three-or more lamp);
- b. non-lensed, fluorescent fixtures;
- c. fitted with type T-1, T-2, T-4, T-5, T-6, T-8 (~~or PL type~~) or compact fluorescent lamps from 5 to 50 watts (but not T-10 or T-12 lamps); and
- d. electronic ballasts (electronic ballasts that screw into medium base sockets do not comply with this section).

EXCEPTIONS:

1. Up to a total of 5 percent of installed lighting fixtures need not be ballasted and may use any type of lamp.
2. Clear safety lenses are allowed in food prep and serving areas and patient care areas in otherwise compliant fixtures.
3. Exit lights are not included in the count of fixtures provided that they do not exceed 5 watts per fixture and are light emitting diode (LED) type or T-1 fluorescent type only. (See the Uniform Fire Code for face illumination footcandle requirements and other requirements.)

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

**WAC 51-11-1530 Lighting power allowance option.** The installed lighting wattage shall not exceed the lighting power allowance. Lighting wattage includes lamp and ballast wattage. Wattage for fluorescent lamps and ballasts shall be tested per ANSI Standard C82.2-1984.

The wattage used for any unballasted fixture shall be the maximum UL listed wattage for that fixture regardless of the lamp installed. The wattage used for track lighting shall be:

- a. for line voltage track, 50 watts per lineal foot of track or actual luminaire wattage, whichever is greater
- b. for low voltage track, 25 watts per lineal foot of track or the VA rating of the transformer, whichever is greater.

No credit towards compliance with the lighting power allowances shall be given for the use of any controls, automatic or otherwise.

Exit lights that are 5 watts or less per fixture shall not be included in the lighting power allowance calculations. Other exit lights shall be included in the lighting power allowance calculations.

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

**WAC 51-11-1531 Interior lighting power allowance.** The interior lighting power allowance shall be calculated by multiplying the gross interior floor area, in square feet, by the appropriate unit lighting power allowance, in watts per square foot, for the use as specified in Table 15-1. Accessory uses, including corridors, lobbies and toilet facilities shall be included with the primary use.

~~((If multiple uses are intended,))~~ The lighting power allowance for each ~~((type of))~~ use shall be separately calculated and summed to obtain the interior lighting power allowance.

In cases where a lighting plan for only a portion of a building is submitted, the interior lighting power allowance shall be based on the gross interior floor area covered by the plan. Plans submitted for common areas only, including corridors, lobbies and toilet facilities shall use the lighting power allowance for common areas in Table 15-1.

When insufficient information is known about the specific use of the space, the allowance shall be based on the apparent intended use of the space.

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

**WAC 51-11-1532 Exterior lighting power allowance.** The exterior lighting power allowance shall be the sum of the calculated allowances for parking, outdoor areas and building exteriors. The lighting allowance for covered parking, open parking and outdoor areas that are illuminated shall be 0.20 watts per square foot. The lighting allowance for building exteriors shall be calculated either by multiplying the building facade area by 0.25 watts per square foot or multiplying the building perimeter

in feet by 7.5 watts per linear foot.

EXCEPTIONS:

- 1.
- 2.

Group (~~M~~) U occupancy accessory to Group R-3 occupancy.

For covered parking, 0.30 w/sf may be used for the lighting provided that the ceilings and walls are painted or stained with a reflectance value of 0.70 or higher.

**TABLE 15-1**  
Unit Lighting Power Allowance (LPA)

Use <sup>1</sup>	LPA <sup>2</sup> (watts/sq. ft.)
Painting, welding, carpentry, machine shops	2.3
Barber shops, beauty shops	2.0
Hotel banquet/conference/exhibition hall <sup>3,4</sup>	2.0
Laboratories	2.0
Aircraft repair hangars	1.5
Cafeterias, fast food establishments <sup>5</sup>	1.5
Factories, workshops, handling areas	1.5
Gas stations, auto repair shops <sup>6</sup>	1.5
Institutions	1.5
Libraries <sup>5</sup>	1.5
Nursing homes and hotel/motel guest rooms	1.5
Retail <sup>10</sup> , retail banking	1.5
Wholesale stores (pallet rack shelving)	1.5
Mall concourses	1.4
Schools buildings (Group E occupancy only), school classrooms, day care centers	1.35
Laundries	1.3
Office buildings, office/administrative areas in facilities of other use types (including but not limited to schools, hospitals, institutions, museums, banks, churches) <sup>5,7,11</sup>	1.2
Police and fire stations <sup>8</sup>	1.2
Atria (atriums)	1.0
Assembly spaces <sup>9</sup> , auditoriums, gymnasia <sup>9</sup> , theaters	1.0
Group R-1 common areas	1.0
Process plants	1.0
Restaurants/bars <sup>5</sup>	1.0
((Retail A <sup>10</sup>	1.0
Retail B <sup>10</sup> , Retail banking	1.5))
Locker and/or shower facilities	0.8
Warehouses <sup>11</sup> , storage areas	0.5
Aircraft storage hangars	0.4
Parking garages	See Section 1532

Use <sup>1</sup>	LPA <sup>2</sup> (watts/sq. ft.)
<b>Plans Submitted for Common Areas Only<sup>7</sup></b>	
<del>((Common area, corridors, lobbies))</del> <u>Main floor building lobbies<sup>7</sup> (except mall concourses)</u>	<del>((0.8))</del> <u>1.2</u>
<u>Common areas, corridors, toilet facilities and washrooms, elevator lobbies</u>	0.8

### Footnotes for Table 15-1

1. In cases in which a general use and a specific use are listed, the specific use shall apply. In cases in which a use is not mentioned specifically, the *Unit Power Allowance* shall be determined by the building official. This determination shall be based upon the most comparable use specified in the table. See Section 1512 for exempt areas.
2. The watts per square foot may be increased, by two percent per foot of ceiling height above twenty feet, unless specifically directed otherwise by subsequent footnotes.
3. Watts per square foot of room may be increased by two percent per foot of ceiling height above twelve feet.
4. For all other spaces, such as seating and common areas, use the *Unit Light Power Allowance* for assembly.
5. Watts per square foot of room may be increased by two percent per foot of ceiling height above nine feet.
6. Includes pump area under canopy.
7. In cases in which a lighting plan is submitted for only a portion of a floor, a *Unit Lighting Power Allowance* of 1.35 may be used for usable office floor area and 0.80 watts per square foot shall be used for the common areas, which may include elevator space, lobby area and rest rooms. Common areas, as herein defined do not include mall concourses.
8. For the fire engine room, the *Unit Lighting Power Allowance* is 1.0 watts per square foot.
9. For indoor sport tournament courts with adjacent spectator seating, the *Unit Lighting Power Allowance* for the court area is 2.6 watts per square foot.
10. ~~((For both Retail A and Retail B, light))~~ Display window illumination installed within 2 feet of the window, lighting for free-standing display where the lighting moves with the display, and building showcase illumination ((and display window illumination installed within two feet of the window are exempt.

~~Retail A allows a Unit Lighting Power Allowance of 1.0 watts~~

~~per square foot. Ceiling mounted adjustable tungsten halogen and HID merchandise display illuminaries are exempt.~~

~~Retail B allows a Unit Lighting Power Allowance of 1.5 watts per square foot, including all ceiling mounted merchandise display luminaries)) where the lighting is enclosed within the showcase are exempt.~~

An additional 1.5 w/ft<sup>2</sup> of merchandise display luminaires are exempt provided that they comply with all three of the following:

(a) located on ceiling-mounted track or directly on or recessed into the ceiling itself (not on the wall).

(b) adjustable in both the horizontal and vertical axes (vertical axis only is acceptable for fluorescent and other fixtures with two points of track attachment).

(c) fitted with tungsten halogen, fluorescent, or high intensity discharge lamps.

This additional lighting power is allowed only if the lighting is actually installed.

11. Provided that a floor plan, indicating rack location and height, is submitted, the square footage for a warehouse may be defined, for computing the interior *Unit Lighting Power Allowance*, as the floor area not covered by racks plus the vertical face area (access side only) of the racks. The height allowance defined in footnote 2 applies only to the floor area not covered by racks.

## CHAPTER 17 STANDARDS

Note: For nonresidential standards, see chapter 7.

## CHAPTER 20 DEFAULT HEAT-LOSS COEFFICIENTS

Note: For nonresidential defaults, see chapter 10.

REFERENCE STANDARD ((~~COMMERCIAL~~)) NONRESIDENTIAL  
BUILDING DESIGN BY SYSTEMS ANALYSIS

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

WAC 51-11-99902 Section 2--General principles and requirements.

**2.1 Energy Analysis:** Compliance with this Standard will require an analysis of the annual energy usage, hereinafter called an annual energy analysis.

A building designed in accordance with this Standard will be deemed as complying with this Code, if

a. The calculated annual energy consumption is not greater than that of a corresponding "standard design," as defined below and in Section 3,

and;

b. Whose enclosure elements and energy-consuming systems comply with Sections 1310 through 1314, 1410 through ((1415)) 1416, 1440 through ((1442)) 1443, 1450 through 1454 and 1510 through 1513. Buildings shall only vary from those requirements in Sections 1330 through 1334, 1432 through ((1438)) 1439 and 1530 through 1532 where those variations have been accurately and completely modeled. Where variations are not specifically analyzed, the building shall comply with these requirements.

For a proposed building design to be considered similar to a "standard design," it shall utilize the same energy source(s) for the same functions and have equal floor area and the same ratio of envelope area to floor area, environmental requirements, occupancy, climate data and usage operational schedule. Inputs to the energy analysis relating to occupancy and usage shall correspond to the expected occupancy and usage of the building.

Except as noted below, the systems identified, and, to the extent possible, the assumptions made in assigning energy inputs to each system, shall be the same for the standard design and the proposed design. When electrically driven heat pumps, other than multiple units connected to a common water loop, are employed to provide all or part of the heat for the proposed design, the standard design shall also, for the purposes of the analysis, assume that electrically driven heat pump, in conformance with

Chapter 14 of the Code and having capacity at least as great as those used in the proposed design are employed.

**2.2 Design:** The standard design and the proposed design shall be designed on a common basis as specified herein:

a. The comparison shall be expressed as kBtu input per square foot of conditioned floor area per year at the building site. Buildings which use electricity as the only fuel source, comparisons may be expressed in kWh. When converting electricity in kWh to kBtu a multiplier of 3.413 kWh/kBtu shall be used.

b. If the proposed design results in an increase in consumption of one energy source and a decrease in another energy source, even though similar sources are used for similar purposes, the difference in each energy source shall be converted to equivalent energy units for purposes of comparing the total energy used.

**2.3 Analysis Procedure:** The analysis of the annual energy usage of the standard and the proposed building and system design shall meet the following criteria:

a. The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be detailed to permit the evaluation of effect of factors specified in Section 2.4.

b. The calculation procedure used to simulate the operation of the building and its service systems through a full-year operating period shall be detailed to permit the evaluation of the effect of system design, climatic factors, operational characteristics and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of systems and equipment. The calculation procedure shall be based upon 8,760 hours of operation of the building and its service systems and shall utilize the design methods, specified in Standards RS-27, -11, -12 and -13 listed in Chapter 7 (~~and~~ ~~±7~~) of the Code or in other programs approved by the building official.

**2.4 Calculation Procedure:** The calculation procedure shall cover the following items:

a. Design requirements--Design heating conditions and design cooling conditions as defined in Chapter (~~±2~~) 2 of the Code.

b. Climatic data--Coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.

c. Building data--Orientation, size, shape, mass, air and heat transfer characteristics.

d. Operational characteristics--Temperature, humidity, ventilation, illumination and control mode for occupied and unoccupied hours.

e. Mechanical equipment--Design capacity and part load profile.

f. Building loads--Internal heat generation, lighting, equipment and number of people during occupied and unoccupied periods.

((EXCEPTION:

Proposed designs having an area of 25,000 square feet or less are exempt from the full-year energy analysis described in section 2.3(b). However, comparison of energy consumption between the proposed design and the standard design shall be provided based on one of the programs suggested in Section 4.2 for these buildings.))

**2.5 Documentation:** All analyses submitted shall be accompanied by an energy analysis comparison report. The report shall provide technical detail on the two building and system designs and on the data used in and resulting from the comparative analysis to verify that both the analysis and the designs meet the criteria of Section 1.

The calculation procedure for the standard design and the proposed design shall separately identify the calculated annual energy consumption for each different occupancy type, if possible, for each of the following end uses:

- a. Interior lighting;
- b. Parking lighting;
- c. Exterior lighting;
- d. Space heating;
- e. Space cooling;
- f. Interior ventilation/fans;
- g. Parking ventilation/fans;
- h. Exhaust fans;
- i. Service water heating;
- j. Elevators;
- k. Appliances.

Energy consumption of the following items shall be included but is not required to be separated out by each individual item.

- a. Office equipment;
- b. Refrigeration other than comfort cooling;
- c. Cooking; and
- d. Any other energy-consuming equipment.

The specifications of the proposed building project used in the analysis shall be as similar as is reasonably practical to those in the plans submitted for a building permit.

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

**WAC 51-11-99903 Section 3--Specific modeling assumptions.**

The specific modeling assumptions consist of methods and assumptions for calculating the standard energy consumption for the standard building and the proposed energy consumption of the proposed design. In order to maintain consistency between the standard and the proposed design energy consumptions, the input assumptions in this section shall be used.

"Prescribed" assumptions shall be used without variation.

"Default" assumptions shall be used unless the designer can demonstrate that a different assumption better characterizes the building's use over its expected life. Any modification of a default assumption shall be used in modeling both the standard building and the proposed design unless the designer demonstrates a clear cause to do otherwise.

**3.1 Orientation and Shape:** The standard building shall consist of the same number of stories and gross floor area for each story as the proposed design. Each floor shall be oriented exactly as the proposed design. The geometric form shall be the same as the proposed design.

**3.2 Internal Loads:** Internal loads shall be modeled as noted in the following parts of Section 3.2. The systems specified for calculating the standard energy consumption in Section 3.2 are intended only as constraints in calculating the consumption. They are not intended as requirements or recommendations for systems to be used in the proposed building or for the calculation of the proposed energy consumption.

**3.2.1 Occupancy:** Occupancy schedules shall be default assumptions. The same assumptions shall be made in computing proposed energy consumption as were used in calculating the standard energy consumption. Occupancy levels vary by building type and time of day. Table 3-1 establishes the density presented as ft<sup>2</sup>/person of conditioned floor area that will be used by each building type. Table 3-2 establishes the percentage of the people that are in the building by hours of the day for each building type.

**3.2.2 Lighting:** The interior and exterior lighting power allowance for calculating the standard energy consumption shall be determined from Sections 1531 and 1532. The lighting power used to calculate the proposed energy consumption shall be the actual lighting power of the proposed lighting design. Exempt lighting in the standard design shall be equal to the exempt lighting in the proposed design.

Lighting levels in buildings vary based on the type of uses within buildings, by area and by time of day. Table 3-2 contains the lighting energy profiles which establish the percentage of the lighting load that is switched ON in each prototype or reference building by hour of the day. These profiles are default assumptions and can be changed if required when calculating the standard energy consumption to provide, for example, a 12 hour rather than an 8 hour work day or to reflect the use of automatic lighting controls. The lighting schedules used in the standard and proposed designs shall be identical and shall reflect the type of controls to be installed in the proposed design. The controls in the proposed design shall comply with the requirements in Section 1513 and no credit shall be given for the use of any additional controls, automatic or otherwise.

**3.2.3 Receptacle:** Receptacle loads and profiles are default assumptions. The same assumptions shall be made in calculating proposed energy consumption as were used in calculating the

standard energy consumption. Receptacle loads include all general service loads that are typical in a building. These loads should include additional process electrical usage but exclude HVAC primary or auxiliary electrical usage. Table 3-1 establishes the density in W/ft<sup>2</sup> to be used. The receptacle energy profiles shall be the same as the lighting energy profiles in Table 3-2. This profile establishes the percentage of the receptacle load that is switched ON by hour of the day and by building type.

### **3.3 Envelope**

**3.3.1 Insulation and Glazing:** Glazing area and U-factor of the standard building envelope shall be determined by using the Target UA requirements of Equation 13-1 and U-factor values in Table 13-1 or 13-2. The glazing solar heat gain coefficient (SHGC) or shading coefficient of the standard building shall be the lesser of 0.65 and the SHGC required by Table 13-1 or 13-2 for the vertical or overhead glazing area for the appropriate wall type. The opaque area U-factors of the standard building shall be determined by using the Target UA requirements from Equation 13-1 including the appropriate mass for walls. The insulation characteristics and glazing area are prescribed assumptions for the standard building for calculating the standard energy consumption. In the calculation of the proposed energy consumption of the proposed design, the envelope characteristics of the proposed design shall be used. The standard design shall use the maximum glazing areas listed in Tables 13-1 or 13-2 for the appropriate use. The distribution of vertical glazing in the gross wall area of the standard design shall be equal to the distribution of vertical glazing in the proposed design or shall constitute an equal percentage of gross wall area on all sides of the standard building. The distribution of overhead glazing in the gross roof/ceiling area of the standard design shall be equal to the distribution of overhead glazing in the proposed design. The distribution of doors in the gross opaque wall area of the standard design shall be identical to the distribution of doors in the proposed design.

**3.3.2 Infiltration:** For standard and proposed buildings, infiltration assumptions shall be equal.

**3.3.3 Envelope and Ground Absorptivities:** For the standard building, absorptivity assumptions shall be default assumptions for computing the standard energy consumption and default assumptions for computing the proposed energy consumption. The solar absorptivity of opaque elements of the building envelope shall be assumed to be 70 percent. The solar absorptivity of ground surfaces shall be assumed to be 80 percent (20 percent reflectivity).

**3.3.4 Window Treatment:** No draperies or blinds shall be modeled for the standard or proposed building.

**3.3.5 Shading:** For standard building and the proposed design, shading by permanent structures and terrain shall be taken into

account for computing energy consumption whether or not these features are located on the building site. A permanent fixture is one that is likely to remain for the life of the proposed design. Credit may be taken for external shading devices that are part of the proposed design.

**3.4 HVAC Systems and Equipment:** For the standard building, the HVAC system used shall be the system type used in the proposed design. If the proposed HVAC system type does not comply with Sections 1432 through (~~1438~~) 1439, the standard design system shall comply in all respects with those sections.

Exception: When approved by the building official, a prototype HVAC system may be used, if the proposed design system cannot be modified to comply with Sections 1422 and 1432 through (~~1438~~) 1439, as a standard design. Use of prototype HVAC systems shall only be permitted for the building types listed below. For mixed-use buildings, the floor space of each building type is allocated within the floor space of the standard building. The specifications and requirements for the HVAC systems of prototype buildings shall be those in Table 3-3.

- |                         |                         |
|-------------------------|-------------------------|
| 1. assembly             | 6. restaurant           |
| 2. health/institutional | 7. retail (mercantile)  |
| 3. hotel/motel          | 8. school (educational) |
| 4. light manufacturing  | 9. warehouse (storage)  |
| 5. office (business)    |                         |

**3.4.1 HVAC Zones:** HVAC zones for calculating the standard energy consumption and proposed energy consumption shall consist of at least four perimeter and one interior zone per floor, with at least one perimeter zone facing each orientation. The perimeter zones shall be fifteen feet in width or one-third the narrow dimension of the building when this dimension is between 30 and 45 feet inclusive or half the narrow dimension of the building when this dimension is less than thirty feet.

Exceptions:

1. Building types such as assembly or warehouse may be modeled as a single zone if there is only one space.
2. Thermally similar zones, such as those facing one orientation on different floors, may be grouped together for the purposes of either the standard or proposed building simulation.

**3.4.2 Process Equipment Sizing:** Process sensible and latent loads shall be equal in calculating both the standard energy consumption and the proposed energy consumption. The designer shall document the installation of process equipment and the size of process loads.

**3.4.3 HVAC Equipment Sizing:** The equipment shall be sized to include the capacity to meet the process loads. For calculating the proposed energy consumption, actual air flow rates and installed equipment size shall be used in the simulation. Equipment sizing in the simulation of the proposed design shall correspond to the equipment intended to be selected for the design and the designer shall not use equipment sized automatically by the simulation tool.

Equipment sizing for the standard design shall be based on the same as the proposed design or lesser sizing ratio of installed system capacity to the design load for heating and for cooling.

Chilled water systems for the standard building shall be modeled using a reciprocating chiller for systems with total

cooling capacities less than 175 tons, and centrifugal chillers for systems with cooling capacities of 175 tons or greater. For systems with cooling capacities of 600 tons or more the standard energy consumption shall be calculated using two centrifugal chillers, lead/lag controlled. Chilled water shall be assumed to be controlled at a constant 44 degree F temperature rise, from 44 degrees F to 56 degrees F, operating at 65 percent combined impeller and motor efficiency. Condenser water pumps shall be sized using a 10 degree F temperature rise, operating at 60 percent combined impeller and motor efficiency. The cooling tower shall be an open circuit, centrifugal blower type sized for the larger of 85 degrees F leaving water temperature or 10 degrees F approach to design wetbulb temperature. The tower shall be controlled to provide a 65 degrees F leaving water temperature whenever weather conditions permit, floating up to design leaving water temperature at design conditions.

**3.4.4 ((~~Variable Speed~~)) Fans:** The ((~~energy~~)) power of the combined fan system per air volume at design conditions (w/cfm) of the proposed design shall be equal to that of the standard design.

Variable air volume fan systems in the standard building shall be variable speed.

**3.5 Service Water Heating:** The service water heating loads for prototype buildings are defined in terms of Btu/person-hour in Table 3-1. The values in the table refer to energy content of the heated water. The service water heating loads from Table 3-1 are default for all buildings. The same service-water-heating load assumptions shall be made in calculating proposed energy consumption as were used in calculating the standard energy consumption. The service water heating system for the standard building shall be modeled as closely as possible as if it were designed in accordance with ((~~the ASHRAE Handbook, 1995 HVAC Systems and Applications Volume~~)) RS-11 and meeting all the requirements of Sections 1440 through ((~~1442~~)) 1443.

### 3.6 Controls

**3.6.1:** All occupied conditioned spaces in standard and proposed design buildings in all climates shall be simulated as being both heated and cooled.

Exceptions:

1. If a building or portion of a building is to be provided with only heating or cooling, both the standard building and the proposed design shall be simulated using the same assumptions.
2. If warehouses are not intended to be mechanically cooled, both the standard and proposed energy consumption shall be modeled assuming no mechanical cooling.

**3.6.2:** Space temperature controls for the standard building, shall be set at 70 degrees F for space heating and 75 degrees F for space cooling, with a deadband in accordance with Section 1412.2. The system shall be OFF during off-hours according to the appropriate schedule in Table 3-2, except that the heating system shall cycle ON if any space should drop below the night setback setting 55 degrees F. There shall be no similar setpoint during the cooling season. Lesser deadband ranges may be used in calculating the

proposed energy consumption.

Exceptions:

1. Setback shall not be modeled in determining either the standard or proposed energy consumption if setback is not realistic for the proposed design such as a facility being operated 24 hours/day. For instance, health facilities need not have night setback during the heating season.
2. If deadband controls are not to be installed, the proposed energy consumption shall be calculated with both heating and cooling thermostat setpoints set to the same value between 70 degrees F and 75 degrees F inclusive, assumed to be constant for the year.

**3.6.3:** When providing for outdoor air ventilation when calculating the standard energy consumption, controls shall be assumed to close the outside air intake to reduce the flow of outside air to 0.0 cfm during "setback" and "unoccupied" periods. Ventilation using inside air may still be required to maintain scheduled setback temperature. Outside air ventilation, during occupied periods, shall be as required by the Washington State Ventilation and Indoor Air Quality Code chapter 51-13 WAC.

**3.6.4:** If humidification is to be used in the proposed design, the same level of humidification and system type shall be used in the standard building.

**TABLE 3-1**  
**Acceptable Occupancy Densities, Receptacle Power Densities and Service Hot Water Consumption<sup>1</sup>**

Building Type	Occupancy Density <sup>2</sup> Sq. Ft./Person (Btu/h•ft <sup>2</sup> )	Receptacle Power Density <sup>3</sup> Watts/Sq. Ft. (Btu/h•ft <sup>2</sup> )	Service Hot Water Quantities <sup>4</sup> Btu/h•person
Assembly	50 (4.60)	0.25 (0.85)	215
Health/Institutional	200 (1.15)	1.00 (3.41)	135
Hotel/Motel	250 (0.92)	0.25 (0.85)	1,110
Light Manufacturing	750 (0.31)	0.20 (0.68)	225
Office	275 (0.84)	0.75 (2.56)	175
Parking Garage	N.A.	N.A.	N.A.
Restaurant	100 (2.30)	0.10 (0.34)	390
Retail	300 (0.77)	0.25 (0.85)	135
School	75 (3.07)	0.50 (1.71)	215
Warehouse	15,000 (0.02)	0.10 (0.34)	225

1. The occupancy densities, receptacle power densities and service hot water consumption values are from ASHRAE Standard 90.1-1989 and addenda.
2. Values are in square feet of conditioned floor area per person. Heat generation in Btu per person per hour is 230 sensible and 190 latent. Figures in parentheses are equivalent Btu per hour per square foot.
3. Values are in Watts per square foot of conditioned floor area. Figures in parentheses are equivalent Btu per hour per square foot. These values are the minimum acceptable. If other process loads are not input (such as for computers, cooking, refrigeration, etc.), it is recommended that receptacle power densities be increased until total process energy consumption is equivalent to 25% of the total.
4. Values are in Btu per person per hour.

**TABLE 3-2A**  
**Assembly Occupancy<sup>1</sup>**

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
2 (1-2am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
6 (5-6am)	0	0	0	5	5	5	on	off	off	0	0	0	0	0	0
7 (6-7am)	0	0	0	40	5	5	on	on	on	0	0	0	0	0	0
8 (7-8am)	0	0	0	40	30	30	on	on	on	0	0	0	0	0	0
9 (8-9am)	20	20	10	40	30	30	on	on	on	0	0	0	0	0	0
10 (9-10am)	20	20	10	75	50	30	on	on	on	5	5	5	0	0	0
11 (10-11am)	20	20	10	75	50	30	on	on	on	5	5	5	0	0	0
12 (11-12pm)	80	60	10	75	50	30	on	on	on	35	20	10	0	0	0
13 (12-1pm)	80	60	10	75	50	65	on	on	on	5	0	0	0	0	0
14 (1-2pm)	80	60	70	75	50	65	on	on	on	5	0	0	0	0	0
15 (2-3pm)	80	60	70	75	50	65	on	on	on	5	0	0	0	0	0
16 (3-4pm)	80	60	70	75	50	65	on	on	on	5	0	0	0	0	0
17 (4-5pm)	80	60	70	75	50	65	on	on	on	5	0	0	0	0	0
18 (5-6pm)	80	60	70	75	50	65	on	on	on	0	0	0	0	0	0
19 (6-7pm)	20	60	70	75	50	65	on	on	on	0	0	0	0	0	0
20 (7-8pm)	20	60	70	75	50	65	on	on	on	0	65	65	0	0	0
21 (8-9pm)	20	60	70	75	50	65	on	on	on	0	30	30	0	0	0
22 (9-10pm)	20	80	70	75	50	65	on	on	on	0	0	0	0	0	0
23 (10-11pm)	10	10	20	25	50	5	on	on	on	0	0	0	0	0	0
24 (11-12am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
Total/Day	710	750	700	1155	800	845	1800	1700	1700	70	125	115	0	0	0
Total/Week		50.50	hours		74.20	hours		124	hours		5.9	hours	0	hours	
Total/Year		2633	hours		3869	hours		6465	hours		308	hours	0	hours	

Wk= Weekday

- Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2B  
Health Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
2 (1-2am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
3 (2-3am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
4 (3-4am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
5 (4-5am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
6 (5-6am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
7 (6-7am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
8 (7-8am)	10	10	0	50	20	5	on	on	on	17	1	1	2	2	0
9 (8-9am)	50	30	5	90	40	10	on	on	on	58	20	1	75	46	2

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
10 (9-10am)	80	40	5	90	40	10	on	on	on	66	28	1	100	70	2
11 (10-11am)	80	40	5	90	40	10	on	on	on	78	30	1	100	70	2
12 (11-12pm)	80	40	5	90	40	10	on	on	on	82	30	1	100	70	2
13 (12-1pm)	80	40	5	90	40	10	on	on	on	71	24	1	75	51	2
14 (1-2pm)	80	40	5	90	40	10	on	on	on	82	24	1	100	51	2
15 (2-3pm)	80	40	5	90	40	10	on	on	on	78	23	1	100	51	2
16 (3-4pm)	80	40	5	90	40	10	on	on	on	74	23	1	100	51	2
17 (4-5pm)	80	40	0	30	40	5	on	on	on	63	23	1	100	51	0
18 (5-6pm)	50	10	0	30	40	5	on	on	on	41	10	1	100	25	0
19 (6-7pm)	30	10	0	30	10	5	on	on	on	18	1	1	52	2	0
20 (7-8pm)	30	0	0	30	10	5	on	on	on	18	1	1	52	0	0
21 (8-9pm)	20	0	0	30	10	5	on	on	on	18	1	1	52	0	0
22 (9-10pm)	20	0	0	30	10	5	on	on	on	10	1	1	28	0	0
23 (10-11pm)	0	0	0	30	10	5	on	on	on	1	1	1	0	0	0
24 (11-12am)	0	0	0	10	10	5	on	on	on	1	1	1	0	0	0
Total/Day	850	380	40	1060	550	160	2400	2400	2400	783	249	24	1136	540	16
Total/Week		46.70	hours		60.10	hours			168	hours		41.88	hours	62.36	hours
Total/Year		2435	hours		3134	hours			8760	hours		2148	hours	3251	hours

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2C  
Hotel/Motel Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	90	90	70	20	20	30	on	on	on	20	20	25	40	44	55
2 (1-2am)	90	90	70	15	20	30	on	on	on	15	15	20	33	35	55
3 (2-3am)	90	90	70	10	10	20	on	on	on	15	15	20	33	35	43
4 (3-4am)	90	90	70	10	10	20	on	on	on	15	15	20	33	35	43
5 (4-5am)	90	90	70	10	10	20	on	on	on	20	20	20	33	35	43
6 (5-6am)	90	90	70	20	10	20	on	on	on	25	25	30	33	35	43
7 (6-7am)	70	70	70	40	30	30	on	on	on	50	40	50	42	40	52
8 (7-8am)	40	50	70	50	30	40	on	on	on	60	50	50	42	32	52
9 (8-9am)	40	50	50	40	40	40	on	on	on	55	50	50	52	45	65
10 (9-10am)	20	30	50	40	40	30	on	on	on	45	50	55	52	45	65
11 (10-11am)	20	30	50	25	30	30	on	on	on	40	45	50	40	42	53
12 (11-12pm)	20	30	30	25	25	30	on	on	on	45	50	50	51	60	60
13 (12-1pm)	20	30	30	25	25	30	on	on	on	40	50	40	51	65	53
14 (1-2pm)	20	30	20	25	25	20	on	on	on	35	45	40	51	65	51
15 (2-3pm)	20	30	20	25	25	20	on	on	on	30	40	30	51	65	50
16 (3-4pm)	30	30	20	25	25	20	on	on	on	30	40	30	51	65	44
17 (4-5pm)	50	30	30	25	25	20	on	on	on	30	35	30	63	65	64

Hour of Day	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
18 (5-6pm)	50	50	40	25	25	20	on	on	on	40	40	40	80	75	62
19 (6-7pm)	50	60	40	60	60	50	on	on	on	55	55	50	86	80	65
20 (7-8pm)	70	60	60	80	70	70	on	on	on	60	55	50	70	80	63
21 (8-9pm)	70	60	60	90	70	80	on	on	on	50	50	40	70	75	63
22 (9-10pm)	80	70	80	80	70	60	on	on	on	55	55	50	70	75	63
23 (10-11pm)	90	70	80	60	60	50	on	on	on	45	40	40	45	55	40
24 (11-12am)	90	70	80	30	30	30	on	on	on	25	30	20	45	55	40
Total/Day	1390	1390	1300	855	785	810	2400	2400	2400	915	930	900	1217	1303	1287
Total/Week	96.40 hours			58.70 hours			168.0 hours			64.05 hours			86.75 hours		
Total/Year	5026 hours			3061 hours			8760 hours			3340 hours			4523 hours		

Wk= Weekday

- Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2D  
Light Manufacturing Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
2 (1-2am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
6 (5-6am)	0	0	0	10	5	5	off	off	off	8	8	7	0	0	0
7 (6-7am)	10	10	5	10	10	5	on	on	off	7	7	4	0	0	0
8 (7-8am)	20	10	5	30	10	5	on	on	off	19	11	4	35	16	0
9 (8-9am)	95	30	5	90	30	5	on	on	off	35	15	4	69	14	0
10 (9-10am)	95	30	5	90	30	5	on	on	off	38	21	4	43	21	0
11 (10-11am)	95	30	5	90	30	5	on	on	off	39	19	4	37	18	0
12 (11-12pm)	95	30	5	90	30	5	on	on	off	47	23	6	43	25	0
13 (12-1pm)	50	10	5	80	15	5	on	on	off	57	20	6	58	21	0
14 (1-2pm)	95	10	5	90	15	5	on	on	off	54	19	9	48	13	0
15 (2-3pm)	95	10	5	90	15	5	on	on	off	34	15	6	37	8	0
16 (3-4pm)	95	10	5	90	15	5	on	on	off	33	12	4	37	4	0
17 (4-5pm)	95	10	5	90	15	5	on	on	off	44	14	4	46	5	0
18 (5-6pm)	30	5	5	50	5	5	on	on	off	26	7	4	62	6	0
19 (6-7pm)	10	5	0	30	5	5	on	off	off	21	7	4	20	0	0
20 (7-8pm)	10	0	0	30	5	5	on	off	off	15	7	4	12	0	0
21 (8-9pm)	10	0	0	20	5	5	on	off	off	17	7	4	4	0	0
22 (9-10pm)	10	0	0	20	5	5	on	off	off	8	9	7	4	0	0
23 (10-11pm)	5	0	0	10	5	5	off	off	off	5	5	4	0	0	0
24 (11-12am)	5	0	0	5	5	5	off	off	off	5	5	4	0	0	0

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
Total/Day	920	200	60	1040	280	120	1600	1200	0	537	256	113	555	151	0
Total/Week	48.60 hours			56.00 hours			92.00 hours			30.54 hours			29.26 hours		
Total/Year	2534 hours			2920 hours			4797 hours			1592 hours			1526 hours		

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2E  
Office Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
2 (1-2am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	5	5	4	0	0	0
6 (5-6am)	0	0	0	10	5	5	off	off	off	8	8	7	0	0	0
7 (6-7am)	10	10	5	10	10	5	on	on	off	7	7	4	0	0	0
8 (7-8am)	20	10	5	30	10	5	on	on	off	19	11	4	35	16	0
9 (8-9am)	95	30	5	90	30	5	on	on	off	35	15	4	69	14	0
10 (9-10am)	95	30	5	90	30	5	on	on	off	38	21	4	43	21	0
11 (10-11am)	95	30	5	90	30	5	on	on	off	39	19	4	37	18	0
12 (11-12pm)	95	30	5	90	30	5	on	on	off	47	23	6	43	25	0
13 (12-1pm)	50	10	5	80	15	5	on	on	off	57	20	6	58	21	0
14 (1-2pm)	95	10	5	90	15	5	on	on	off	54	19	9	48	13	0
15 (2-3pm)	95	10	5	90	15	5	on	on	off	34	15	6	37	8	0
16 (3-4pm)	95	10	5	90	15	5	on	on	off	33	12	4	37	4	0
17 (4-5pm)	95	10	5	90	15	5	on	on	off	44	14	4	46	5	0
18 (5-6pm)	30	5	5	50	5	5	on	on	off	26	7	4	62	6	0
19 (6-7pm)	10	5	0	30	5	5	on	off	off	21	7	4	20	0	0
20 (7-8pm)	10	0	0	30	5	5	on	off	off	15	7	4	12	0	0
21 (8-9pm)	10	0	0	20	5	5	on	off	off	17	7	4	4	0	0
22 (9-10pm)	10	0	0	20	5	5	on	off	off	8	9	7	4	0	0
23 (10-11pm)	5	0	0	10	5	5	off	off	off	5	5	4	0	0	0
24 (11-12am)	5	0	0	5	5	5	off	off	off	5	5	4	0	0	0
Total/Day	920	200	60	1040	280	120	1600	1200	0	537	256	113	555	151	0
Total/Week	48.60 hours			56.00 hours			92.00 hours			30.54 hours			29.26 hours		
Total/Year	2534 hours			2920 hours			4797 hours			1592 hours			1526 hours		

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

**TABLE 3-2F  
Parking Garage Occupancy<sup>1</sup>**

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)				100	100	100									
2 (1-2am)				100	100	100									
3 (2-3am)				100	100	100									
4 (3-4am)				100	100	100									
5 (4-5am)				100	100	100									
6 (5-6am)				100	100	100									
7 (6-7am)				100	100	100									
8 (7-8am)				100	100	100									
9 (8-9am)				100	100	100									
10 (9-10am)				100	100	100									
11 (10-11am)				100	100	100									
12 (11-12pm)		N/A		100	100	100									
13 (12-1pm)				100	100	100									
14 (1-2pm)				100	100	100									
15 (2-3pm)				100	100	100									
16 (3-4pm)				100	100	100									
17 (4-5pm)				100	100	100									
18 (5-6pm)				100	100	100									
19 (6-7pm)				100	100	100									
20 (7-8pm)				100	100	100									
21 (8-9pm)				100	100	100									
22 (9-10pm)				100	100	100									
23 (10-11pm)				100	100	100									
24 (11-12am)				100	100	100									
Total/Day				2400	2400	2400									
Total/Week															
Total/Year															

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

**TABLE 3-2G  
Restaurant Occupancy<sup>1</sup>**

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	15	30	20	15	20	20	on	on	on	20	20	25	0	0	0
2 (1-2am)	15	25	20	15	15	15	on	on	on	15	15	20	0	0	0
3 (2-3am)	5	5	5	15	15	15	on	on	on	15	15	20	0	0	0

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
4 (3-4am)	0	0	0	15	15	15	off	off	off	0	0	0	0	0	0
5 (4-5am)	0	0	0	15	15	15	off	off	off	0	0	0	0	0	0
6 (5-6am)	0	0	0	20	15	15	off	off	off	0	0	0	0	0	0
7 (6-7am)	0	0	0	40	30	30	off	off	off	0	0	0	0	0	0
8 (7-8am)	5	0	0	40	30	30	on	off	off	60	0	0	0	0	0
9 (8-9am)	5	0	0	60	60	50	on	off	off	55	0	0	0	0	0
10 (9-10am)	5	5	0	60	60	50	on	on	off	45	50	0	0	0	0
11 (10-11am)	20	20	10	90	80	70	on	on	on	40	45	50	0	0	0
12 (11-12pm)	50	45	20	90	80	70	on	on	on	45	50	50	0	0	0
13 (12-1pm)	80	50	25	90	80	70	on	on	on	40	50	40	0	0	0
14 (1-2pm)	70	50	25	90	80	70	on	on	on	35	45	40	0	0	0
15 (2-3pm)	40	35	15	90	80	70	on	on	on	30	40	30	0	0	0
16 (3-4pm)	20	30	20	90	80	70	on	on	on	30	40	30	0	0	0
17 (4-5pm)	25	30	25	90	80	60	on	on	on	30	35	30	0	0	0
18 (5-6pm)	50	30	35	90	90	60	on	on	on	40	40	40	0	0	0
19 (6-7pm)	80	70	55	90	90	60	on	on	on	55	55	50	0	0	0
20 (7-8pm)	80	90	65	90	90	60	on	on	on	60	55	50	0	0	0
21 (8-9pm)	80	70	70	90	90	60	on	on	on	50	50	40	0	0	0
22 (9-10pm)	50	65	35	90	90	60	on	on	on	55	55	50	0	0	0
23 (10-11pm)	35	55	20	50	50	50	on	on	on	45	40	40	0	0	0
24 (11-12am)	20	35	20	30	30	30	on	on	on	25	30	20	0	0	0
Total/Day	750	740	485	1455	1365	1115	2000	1800	1700	790	730	625	0	0	0
Total/Week		49.75	hours		97.55	hours		135	hours		53.05	hours		0	hours
Total/Year		2594	hours		5086	hours		7039	hours		2766	hours		0	hours

Wk= Weekday

- Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2H  
Retail Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	4	11	7	0	0	0
2 (1-2am)	0	0	0	5	5	5	off	off	off	5	10	7	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	5	8	7	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	4	6	6	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	4	6	6	0	0	0
6 (5-6am)	0	0	0	5	5	5	off	off	off	4	6	6	0	0	0
7 (6-7am)	0	0	0	5	5	5	on	on	off	4	7	7	0	0	0
8 (7-8am)	10	10	0	20	10	5	on	on	off	15	20	10	12	9	0
9 (8-9am)	20	20	0	50	30	10	on	on	on	23	24	12	22	21	0
10 (9-10am)	50	50	10	90	60	10	on	on	on	32	27	14	64	56	11
11 (10-11am)	50	60	20	90	90	40	on	on	on	41	42	29	74	66	13

Hour of Day	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
12 (11-12pm)	70	80	20	90	90	40	on	on	on	57	54	31	68	68	35
13 (12-1pm)	70	80	40	90	90	60	on	on	on	62	59	36	68	68	37
14 (1-2pm)	70	80	40	90	90	60	on	on	on	61	60	36	71	69	37
15 (2-3pm)	70	80	40	90	90	60	on	on	on	50	49	34	72	70	39
16 (3-4pm)	80	80	40	90	90	60	on	on	on	45	48	35	72	69	41
17 (4-5pm)	70	80	40	90	90	60	on	on	on	46	47	37	73	66	38
18 (5-6pm)	50	60	20	90	90	40	on	on	off	47	46	34	68	58	34
19 (6-7pm)	50	20	10	60	50	20	on	on	off	42	44	25	68	47	3
20 (7-8pm)	30	20	0	60	30	5	on	on	off	34	36	27	58	43	0
21 (8-9pm)	30	20	0	50	30	5	on	on	off	33	29	21	54	43	0
22 (9-10pm)	0	10	0	20	10	5	off	on	off	23	22	16	0	8	0
23 (10-11pm)	0	0	0	5	5	5	off	off	off	13	16	10	0	0	0
24 (11-12am)	0	0	0	5	5	5	off	off	off	8	13	6	0	0	0
Total/Day	720	750	280	1115	985	525	1500	1600	900	662	690	459	844	761	288
Total/Week		46.30	hours		70.85	hours		100	hours		44.59	hours		52.69	hours
Total/Year		2414	hours		3694	hours		5214	hours		2325	hours		2747	hours

Wk= Weekday

- Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-21  
School Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
2 (1-2am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
6 (5-6am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
7 (6-7am)	0	0	0	5	5	5	off	off	off	5	3	3	0	0	0
8 (7-8am)	5	0	0	30	5	5	on	off	off	10	3	3	0	0	0
9 (8-9am)	75	10	0	85	15	5	on	on	off	34	3	5	30	0	0
10 (9-10am)	90	10	0	95	15	5	on	on	off	60	5	5	30	0	0
11 (10-11am)	90	10	0	95	15	5	on	on	off	63	5	5	30	0	0
12 (11-12pm)	80	10	0	95	15	5	on	on	off	72	5	5	30	0	0
13 (12-1pm)	80	10	0	80	15	5	on	on	off	79	5	5	30	0	0
14 (1-2pm)	80	0	0	80	5	5	on	off	off	83	3	5	30	0	0
15 (2-3pm)	80	0	0	80	5	5	on	off	off	61	3	3	30	0	0
16 (3-4pm)	45	0	0	70	5	5	on	off	off	65	3	3	15	0	0
17 (4-5pm)	15	0	0	50	5	5	on	off	off	10	3	3	0	0	0
18 (5-6pm)	5	0	0	50	5	5	on	off	off	10	3	3	0	0	0
19 (6-7pm)	15	0	0	35	5	5	on	off	off	19	3	3	0	0	0
20 (7-8pm)	20	0	0	35	5	5	on	off	off	25	3	3	0	0	0

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
21 (8-9pm)	20	0	0	35	5	5	on	off	off	22	3	3	0	0	0
22 (9-10pm)	10	0	0	30	5	5	on	off	off	22	3	3	0	0	0
23 (10-11pm)	0	0	0	5	5	5	off	off	off	12	3	3	0	0	0
24 (11-12am)	0	0	0	5	5	5	off	off	off	9	3	3	0	0	0
Total/Day	710	50	0	990	170	120	1500	500	0	691	80	84	285	0	0
Total/Week	36.00 hours			52.40 hours			80.00 hours			36.19 hours			14.25 hours		
Total/Year	1877 hours			2732 hours			4171 hours			1887 hours			743 hours		

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

TABLE 3-2J  
Warehouse Occupancy<sup>1</sup>

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	2	2	2	0	0	0
2 (1-2am)	0	0	0	5	5	5	off	off	off	2	2	2	0	0	0
3 (2-3am)	0	0	0	5	5	5	off	off	off	2	2	2	0	0	0
4 (3-4am)	0	0	0	5	5	5	off	off	off	2	2	2	0	0	0
5 (4-5am)	0	0	0	5	5	5	off	off	off	5	2	2	0	0	0
6 (5-6am)	0	0	0	5	5	5	off	off	off	7	2	2	0	0	0
7 (6-7am)	0	0	0	5	5	5	off	off	off	7	2	2	0	0	0
8 (7-8am)	15	0	0	40	5	5	on	off	off	10	2	2	0	0	0
9 (8-9am)	70	20	0	70	8	5	on	on	off	30	6	2	0	0	0
10 (9-10am)	90	20	0	90	24	5	on	on	off	36	12	2	0	0	0
11 (10-11am)	90	20	0	90	24	5	on	on	off	36	12	2	30	0	0
12 (11-12pm)	90	20	0	90	24	5	on	on	off	46	17	2	0	0	0
13 (12-1pm)	50	10	0	80	5	5	on	on	off	57	4	4	0	0	0
14 (1-2pm)	85	10	0	90	5	5	on	on	off	43	4	4	0	0	0
15 (2-3pm)	85	10	0	90	5	5	on	on	off	38	2	2	0	0	0
16 (3-4pm)	85	10	0	90	5	5	on	on	off	40	2	2	40	0	0
17 (4-5pm)	20	0	0	90	5	5	on	off	off	30	2	2	0	0	0
18 (5-6pm)	0	0	0	30	5	5	off	off	off	18	2	2	0	0	0
19 (6-7pm)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
20 (7-8pm)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
21 (8-9pm)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
22 (9-10pm)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
23 (10-11pm)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
24 (11-12am)	0	0	0	5	5	5	off	off	off	3	2	2	0	0	0
Total/Day	680	120	0	915	180	120	1000	800	0	429	91	52	70	0	0
Total/Week	35.20 hours			48.75 hours			58.00 hours			22.88 hours			3.50 hours		

Hour of Day (time)	Schedule for Occupancy			Schedule for Lighting Receptacle			Schedule for HVAC System			Schedule for Service Hot Water			Schedule for Elevator		
	Percent of Maximum Load			Percent of Maximum Load						Percent of Maximum Load			Percent of Maximum Load		
	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun	Wk	Sat	Sun
Total/Year	1835 hours			2542 hours			3024 hours			1193 hours			182 hours		

Wk= Weekday

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5% emergency lighting has been added for all off hours. Elevator schedules, except for restaurants, are from the U.S. Department of Energy Standard Evaluation Techniques except changed to 0% when occupancy is 0%. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

**TABLE 3-3**  
**HVAC Systems of Prototype Buildings<sup>3</sup>**

Use	System #	Remarks
1. Assembly		
a. Churches (any size)	1	
b. $\leq 50,000 \text{ ft}^2$ or $\leq 3$ floors	1 or 3	Note 2
c. $> 50,000 \text{ ft}^2$ or $> 3$ floors	3	
2. Health		
a. Nursing Home (any size)	2	
b. $\leq 15,000 \text{ ft}^2$	1	
c. $> 15,000 \text{ ft}^2$ and $\leq 50,000 \text{ ft}^2$	4	Note 3
d. $> 50,000 \text{ ft}^2$	5	Note 3,4
3. Hotel/Motel		
a. $\leq 3$ Stories	2	Note 6
b. $> 3$ Stories	6	Note 7
4. Light Manufacturing	1 or 3	
5. Office		
a. $\leq 20,000 \text{ ft}^2$	1	
b. $> 20,000 \text{ ft}^2$ and either $\leq 3$ floors or $\leq 75,000 \text{ ft}^2$	4	
c. $> 75,000 \text{ ft}^2$ or $> 3$ floors	5	
6. Restaurant	1 or 3	Note 2
7. Retail		
a. $\leq 50,000 \text{ ft}^2$	1 or 3	Note 2
b. $> 50,000 \text{ ft}^2$	4 or 5	Note 2
8. Schools		
a. $\leq 75,000 \text{ ft}^2$ or $\leq 3$ floors	1	
b. $> 75,000 \text{ ft}^2$ or $> 3$ floors	3	
9. Warehouse		Note 5

Footnote to TABLE 3-3: The system and energy types presented in this table are not intended as requirements or recommendations for the proposed design. Floors areas in the table are the total conditioned floor areas for the listed use in the building. The number of floors indicated in the table is the total number of occupied floors for the listed use.

**TABLE 3-3 (cont.)**  
**HVAC System Descriptions for Prototype Buildings<sup>1</sup>**

HVAC Component	System #1	System #2
System Description	Packaged rooftop single zone, one unit per zone.	Packaged terminal air conditioner with space heater or heat pump, heating or cooling unit per zone.

HVAC Component	System #1	System #2
Fan System Design Supply Circulation Rate	Note 10	Note 11
Supply Fan Control	Constant volume.	Fan cycles with call for heating or cooling.
Return Fan Control	N.A.	N.A.
Cooling System	Direct expansion air cooled	Direct expansion air cooled.
Heating System	Furnace, heat pump, or electric resistance.	Heat pump with electric resistance auxiliary or air conditioner with space heater.
Remarks	Drybulb economizer per Section 1433, heat recovery if required by Section 1436.	No economizer, if not required by Section 1433.

**TABLE 3-3 (cont.)  
HVAC Systems Descriptions for Prototype Buildings<sup>1</sup>**

HVAC Component	System #3	System #4
System Description	Air handler per zone with central plant.	Packaged rooftop VAV with perimeter reheat and fan-powered terminal units.
Fan System Design Supply Circulation Rate	Note 10	Note 10
Supply Fan Control	Constant volume.	VAV with forward curved centrifugal fan and variable inlet fans.
Return Fan Control	Constant volume.	VAV with forward curved centrifugal fan and discharge dampers.
Cooling System	Chilled water (Note 12)	Direct expansion air cooled.
Heating System	Hot water (Note 13)	Hot water (Note 13) or electric resistance.
Remarks	Drybulb economizer per Section 1433, heat recovery if required by Section 1436.	Drybulb economizer per Section 1433. Minimum VAV setting per Section 1435 Exception 1, Supply air reset by zone of greatest cooling demand, heat recovery if required by Section 1436.

**TABLE 3-3 (cont.)  
HVAC System Descriptions for Prototype Buildings<sup>1</sup>**

HVAC Component	System #5	System #6
System Description	Built-up central VAV with perimeter reheat and fan-powered terminal units	Four-pipe fan coil per zone with central plant.

HVAC Component	System #5	System #6
Fan System Design Supply Circulation Rate	Note 10	Note 10
Supply Fan Control	VAV with air-foil centrifugal fan and AC frequency variable speed drive.	Fan cycles with call for heating or cooling.
Return Fan Control	VAV with air-foil centrifugal fan and AC frequency variable speed drive.	NA
Cooling System	Chilled water (Note 12)	Chilled water (Note 12)
Heating System	Hot water (Note 13) or electric resistance.	Hot water (Note 13) or electric resistance.
Remarks	Drybulb economizer per Section 1433. Minimum VAV setting per Section 1435 Exception 1, Supply air rest by zone of greatest cooling demand, heat recovery if required by Section 1436.	No economizer, if not required by Section 1433.

Numbered Footnotes for TABLE 3-3  
HVAC System Descriptions for Prototype Buildings

1. The systems and energy types presented in this Table are not intended as requirements or recommendations for the proposed design.
2. For occupancies such as restaurants, assembly and retail that are part of a mixed use building which, according to Table 3-3, includes a central chilled water plant (systems 3, 5, or 6), chilled water system type 3 or 5 shall be used as indicated in the table.
3. Constant volume may be used in zones where pressurization relationships must be maintained by code. Where constant volume is used, the system shall have heat recovery if required by Section 1436. VAV shall be used in all other areas, in accordance with Sections 1432 through ~~((1438))~~ 1439.
4. Provide run-around heat recovery systems for all fan systems with a minimum outside air intake greater than 70%. Recovery effectiveness shall be 0.50.
5. If a warehouse is not intended to be mechanically cooled, both the standard and proposed designs shall be calculated assuming no mechanical cooling.
6. The system listed is for guest rooms only. Areas such as public areas and back-of-house areas shall be served by system 4. Other areas such as offices and retail shall be served by systems listed in Table 3-3 for these occupancy types.
7. The system listed is for guest rooms only. Areas such as public areas and back-of-house areas shall be served by system 5. Other areas such as offices and retail shall be served by systems listed in Table 3-3 for these occupancy types.
8. Reserved.
9. Reserved.
10. Design supply air circulation rate shall be based on a supply-air-to-room air temperature difference of 20°F. A higher supply air temperature may be used if required to maintain a minimum circulation rate of 4.5 air changes per hour or 15 cfm per person to each zone served by the system, at design conditions. If return fans are specified, they shall be sized for the supply fan capacity less the required minimum ventilation with outside air, or 75% of the supply fan capacity, whichever is larger. Except where noted, supply and return fans shall be operated continuously during occupied hours.
11. Fan energy when included in the efficiency rating of the unit as defined in Section 1411, need not be modeled explicitly for this system. The fan shall cycle with calls for heating or cooling.
12. Chilled water systems shall be modeled using a reciprocating chiller for systems with total cooling capacities less than 175 tons, and centrifugal chillers for systems with cooling capacities of 175 tons or greater. For

systems with cooling capacities of 600 tons or more, the standard design energy consumption shall be calculated using two centrifugal chillers, lead/lag controlled. Chilled water shall be assumed to be controlled at a constant 44°F. Chiller water pumps shall be sized using a 12°F temperature rise, from 44°F to 56°F, operating at 65% combined impeller and motor efficiency. Condenser water pumps shall be sized using a 10°F temperature rise, operating at 60% combined impeller and motor efficiency. The cooling tower shall be an open circuit, centrifugal blower type sized for the larger of 85°F leaving water temperature or 10°F approach to design wetbulb temperature. The tower shall be controlled to provide a 65°F leaving water temperature whenever weather conditions permit, floating up to design leaving water temperatures at design conditions. Chilled water supply temperature shall be reset in accordance with Section 1432.2.2.

13. Hot water system shall include a natural draft fossil fuel or electric boiler. The hot water pump shall be sized based on a 30°F temperature drop, from 180°F to 150°F, operating at a combined impeller and motor efficiency of 60%. Hot water supply temperature shall be reset in accordance with Section 1432.2.2.

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

WAC 51-11-99904 Section 4--Suggested software for systems analysis approach.

~~((4.1 Programs Acceptable for Projects for Full-Year Hourly Analysis))~~

Program Name	Source
<del>((ADM-DOE</del>	<del>ADM Associates 3239 Ramos Circle Sacramento, CA 95827 916-363-8383))</del>
<u>Blast 3.0 (Level ((+93)) 334)</u>	Blast Support Office University of Illinois Dept. of Mechanical and Industrial Engineering 1206 W. Green <u>Street</u> , Room ((30)) <u>140</u> , MEB Urbana, IL 61801 <del>((+800-842-5278))</del> <u>(217) 244-8182</u>
<u>DOE 2.1E</u>	Energy Science and Technology Software Center (ESTSC) PO Box 1220 Oakridge, TN 37831-1020 423-576-2606
<u>DOE 2.1E or DOE 2.2</u>	<u>James J. Hirsch &amp; Associates</u> <u>Building Performance Analysis</u> <u>Software &amp; Consulting</u> <u>12185 Presilla Road</u> <u>Camarillo, CA 93012-9243</u> <u>(805) 532-1045</u>

<b>Program Name</b>	<b>Source</b>
<u>EnergyPlus</u>	<u>Kathy Ellington</u> <u>Lawrence Berkeley National</u> <u>Laboratory (LBNL)</u> <u>Building 90, Room 3147</u> <u>Berkeley, CA 94720-0001</u> <u>(510) 486-5711</u>
ESAS	Ross Meriweather Consulting, Engineering 3315 Outrider San Antonio, TX 78247-4405 210-490-7081
ESP-II	Automated Procedures for Engineering Consultants, Inc. 40 W. 4th Centre, Suite 2100 Dayton, OH 45402 937-228-2602
HAP (( <del>2.02</del> )) <u>3.24</u>	Carrier Building Systems and Services 3215 South 116th St., Suite 133 Tukwila, WA 98168 (206)-439-0097
(( <del>MICRO-DOE2</del>	<del>ACROSFT/CAER-</del> <del>1204-1/2 Washington Avenue</del> <del>Golden, CO 80401</del> <del>303-279-8136</del> ))
Trace 600 Version (( <del>16.08</del> )) <u>18.11</u> or Trace <u>700</u>	The Trane Co. 3600 Pammel Creek Rd. Lacrosse, WI 54601 608-787-3926

~~((4.2 Programs only Acceptable for Commercial Buildings 25,000  
Square Feet or Less~~

<b>Program Name</b>	<b>Source</b>
ADM.2	ADM Associates 3239 Ramos Circle Sacramento, CA 95827 916-363-8383
ASEAM	U.S. Department of Energy Clearinghouse <del>1(800) DOE-EREC (363-3732)</del>
Building Energy Analysis and Easy DOE	Elite Software PO Drawer 1194 Bryan, TX 77806 409-846-2340

Program-Name	Source
ESE	Sea Gate 5100 W. 82nd St., Suite 204 Bloomington, MN 55437 612-844-8000
Market Manager	SRC Systems 2855 Telegraph Ave., Suite 410 Berkeley, CA 94705 510-848-8400
XENCAP 4.5	XENERGY 492 9th Street, Suite 220 Oakland, CA 94607 510-891-0446))

REPEALER

The following sections of the Washington Administrative Code are repealed:

WAC 51-11-1201	Scope.
WAC 51-11-1210	Application of terms.
WAC 51-11-1701	Scope.
WAC 51-11-2000	Default heat-loss coefficients.
WAC 51-11-2001	General.
WAC 51-11-2002	Below grade walls and slabs.
WAC 51-11-2003	On-grade slab floors.
WAC 51-11-2004	Floors over unconditioned space.
WAC 51-11-2005	Above grade walls.
WAC 51-11-2006	Default U-factors for glazing and doors.
WAC 51-11-2007	Ceilings.
WAC 51-11-2008	Reserved.
WAC 51-11-2009	Mass.

*does not exist*