



**RULE-MAKING ORDER**  
(RCW 34.05.360)

**CR-103** (10/1/89)

Agency: State Building Code Council	<input checked="" type="checkbox"/> Permanent Rule <input type="checkbox"/> Emergency Rule
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(1) Date of adoption: September 10, 1993

(2) Purpose: To adopt revised energy code requirements for new and remodeled non-residential buildings

(3) Citation of existing rules affected by this order:  
 Repealed: None  
 Amended: Chapter 51-11, WAC  
 Suspended: None

(4) Authority for adoption:  
 Statute: RCW 19.27A.025  
 Other Authority:

(5.1) **PERMANENT RULE ONLY** 1. 93-08-077 1. April 6, 1993  
 Pursuant to notice filed as WSR 2. 93-10-044 2. April 21, 1993  
 3. 93-16-111 on 3. August 4, 1993 (date).  
 Describe any changes other than editing from proposed to adopted version:  
 None

(5.2) **EMERGENCY RULE ONLY**  
 Pursuant to 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:

(5.3) Any other findings required by other provisions of law as precondition to adoption or effectiveness of rule?  
 Yes  No If yes, explain: These requirements: A. Increase the energy efficiency of newly constructed non-residential buildings. B. Require measures that are technically feasible, commercially available, and cost efficient to building owners and tenants. C. Were adopted by the State Building Code Council by a vote of 13 for and 1 against.

(6) Effective date of rule:  
**Permanent Rules**                      **Emergency Rules**  
 31 days after filing                       Immediately  
 Other (specify) 4/01/94 \*                       Later (specify) \_\_\_\_\_  
 \*(If less than 31 days after filing, specific finding in 5.3 under RCW 34.05.380(3) is required)

**CODE REVISER USE ONLY**

CODE REVISER'S OFFICE  
STATE OF WASHINGTON

OCT 18 1993

TIME: 4:45

WSR: 93-21-052

NAME (TYPE OR PRINT): Gene Colin

SIGNATURE:

TITLE: Chair

DATE: 09/10/93

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

**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 ~~((public assembly, educational, business, mercantile, institutional, storage and))~~ residential occupancies ~~((as well as those portions of factory and industrial occupancies designed primarily for human occupancy))~~ by regulating their exterior envelopes and the selection of their HVAC, service water heating, electrical distribution and illuminating 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 sections 602 and 605, but shall comply with all other requirements for building mechanical systems, service water heating and lighting systems.

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.

101.3.2 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 which is less than or equal to the unimproved

e.isting building, 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:

~~((1. Any Other than Group R Occupancy which is presently unconditioned where the occupancy or use is changed to require conditioning shall be required to be brought into full compliance with this Code.~~

~~2. The use or occupancy of any Other than Group R Occupancies which are presently conditioned may be changed without complying with this code, provided additional heat or cooling is not added.~~

~~3-)) Any Other than Group R Occupancy which is converted to Group R Occupancy shall be brought into full compliance with this Code.~~

~~((4. Any Group R Occupancy which is converted to Other than Group R Occupancy shall be required to comply with all of the provisions of this code if either new or increased heating or cooling is provided.~~

~~5. All Occupancies, which are converted from a Group R Occupancy or an Other than Group R Occupancy or use, to a new Other than Group R Occupancy or use shall comply with the lighting standards set forth in this code unless the existing lighting is not altered.))~~

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 (~~or 5-2~~) of Chapter 5 or the nominal R-values and glazing requirements of the reference case in Tables 6-1 to 6-6 (~~or 6-7~~).

EXCEPTIONS:

1. Untested storm windows may be installed over existing glazing for an assumed U-value of 0.90, however, where glass and

sash are being replaced in Group R Occupancy, glazing with a maximum area weighted average U-value of 0.40 shall be installed where there is an electric resistance space heating system and glazing with a maximum U-value of 0.65 (Climate Zone I) and 0.60 (Climate Zone II) shall be installed where there is any other space heating system.

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 ((Lighting:—Those parts of systems which are altered or replaced in buildings initially constructed subject to the requirements of this Code shall comply with section 505. Other remodels or replacements of lighting systems which are part of a substantial remodel shall comply with sections 505. In addition, remodeling of any size area with or without putting a new ceiling grid or suspension system when reusing existing fixtures and/or adding new ones shall not require compliance with the lighting power budget as long as the installed wattage is maintained or reduced. Remodeling of an entire floor or an entire tenant space that includes a new lighting system with or without a new ceiling grid or suspension system shall require compliance of a lighting power budget of section 505.2. Compliance with switching requirements of section 505.2 is only required when new wiring is being run related to adding fixtures and/or fixtures are being relocated to a new circuit.)) Reserved.~~

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. ~~((This Code shall be the minimum energy code for all other than Group R Occupancies in each town, city and county.))~~

**WAC 51-11-0201 General definitions.**

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.

**AAMA:** American Architectural Manufacturers Association

~~((Accepted analysis methods: Heating/cooling and lighting load calculations performed in accordance with the most current procedures developed by a nationally recognized professional organization and approved by the Building Official.))~~

**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.)

**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.

**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.

~~((Air transport factor: The ratio of the rate of useful sensible heat removal from the conditioned space to the energy input to the supply and return fan motor(s), expressed in consistent units and under the designated operating conditions.))~~

**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**.)

~~((Basement Wall: The opaque portion of a wall which encloses a basement and is partially or totally below grade.))~~

**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:** 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.

**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.

~~((**Clerestory:** A window placed in a wall projecting from a roof plane at sixty degrees or more from the horizontal to admit daylight into the interior of a building. (See Skylight.))~~

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

**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).

~~((**Continuous air barrier:** A system of materials installed during construction that is designed to effectively minimize the transfer of air to or from the conditioned space through [through] unintentional openings in the building envelope.))~~

**Cooled space:** Space within a building which is provided with a positive cooling supply.

**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.)

**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.

**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.

**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.**)

**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-Value:** The perimeter heat loss factor expressed in Btu/hr•ft<sup>2</sup>•°F.

**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.

**Glazing area:** Total area of the glazing measured using the rough opening, and including the glazing, sash, and frame. For doors where the daylight opening area is less than fifty percent 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; includes opaque wall, window 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 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.

**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.

**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:** 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.)

**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. 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.

**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.

**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.)

**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 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.

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

**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:** Air taken from the outdoors and, therefore, not previously circulated through the system.

**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.

**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.

**Radiant slab:** A slab on grade containing heated pipes, ducts, or electric heating cables that constitute a radiant slab 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.

~~((Room air conditioner: A packaged assembly designed as a unit primarily for mounting in a window or through a wall, or as a console, and designed to provide free delivery of conditioned air to an enclosed space, room or zone. It includes a prime source of refrigeration for cooling and dehumidification and means for circulating and cleaning air, and may also include means for ventilating and heating.))~~

**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.

~~((Service water heating demand: The maximum design rate of energy withdrawal from a service water heating system in a designated period of time (usually an hour or a day).))~~

**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.

**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.

**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.

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

**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.)

**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.

~~((Substantially remodeled or rehabilitated: Any alteration or restoration of a building or structure within any twelve-month period, the cost of which exceeds sixty percent of the current replacement value of the particular building or structure.))~~

**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.

~~((Terminal element: The means by which the transformed energy from a system is finally delivered; i.e. registers, diffusers, lighting fixtures, faucets and similar elements.))~~

**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-value applies to the fractional combinations of different materials used in series along the heat flow path.

**Thermal transmittance, overall (U<sup>o</sup>):** The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/hr·ft<sup>2</sup>·°F). The U<sup>o</sup>-value applies to the combined effect of the time rate of heat flows through the various parallel paths, such as windows, 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-Value:** See thermal transmittance.

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

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

**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.

**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.

**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.

~~((Water chilling package of absorption: A factory designed and prefabricated assembly (not necessarily shipped as a single package) of one or more condensers, evaporators (water coolers), absorbers and generators with interconnections and accessories used for chilling water.~~

~~Water chilling package, centrifugal or rotary: A factory designed and prefabricated assembly (not necessarily shipped as one package) or one or more centrifugal or rotary compressors, condensers and water coolers (evaporators) with interconnections and accessories used for chilling water.~~

~~Water chilling package, reciprocating: A factory designed and prefabricated assembly, self contained or condenserless, of one or more reciprocating compressors, condenser (self contained only), water coolers (evaporator) and interconnections and accessories used for chilling water. The condenser may be air, evaporatively or water cooled.))~~

**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 91-01-112, filed 12/19/90, effective 7/1/91)

**WAC 51-11-0401 Scope.**

401.1 General: This chapter establishes design criteria in terms of total energy use by a building, including all of its systems. Analysis of design for all Group R Occupancy shall comply with section 402.1 to 402.6. ~~((Analysis of design for other buildings shall comply with sections 402.2 to 402.6.))~~

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

**WAC 51-11-0503 Building mechanical systems.**

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

EXCEPTION: 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 one hundred fifty percent 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 may exceed the one hundred fifty 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.

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: Each temperature control zone shall include thermostatic controls installed and operated to sequence the use of heating and cooling energy to satisfy the thermal and/or humidity requirement of the zone. Controls shall prevent reheating (heating air that is cooler than system mixed air), recooling (cooling air that is warmer than the system mixed air), mixing or simultaneous supply of warm air (warmer than system return air mixed air) and cold air (cooler than system mixed air), or other simultaneous operation of heating and cooling systems to one zone. For the purposes of this section, system mixed air is defined as system return air mixed with the minimum ventilation air requirement by section 303.

EXCEPTIONS:

1. Variable air volume systems designed to reduce the air supply to each zone during periods of occupancy to the larger of the following:

- a. Thirty percent or less of the peak supply volume.
- b. The minimum allowed to meet ventilation requirements of section 303.
- c. 0.5 cfm/ft<sup>2</sup> of zone conditioned area before reheating, recooling or mixing takes place. Consideration shall be given to supply air temperature reset control.

2. The energy for reheating, or providing warm air in mixing systems, is provided entirely from recovered energy that would otherwise be wasted, or from renewable energy sources. In addition, the system shall comply with section 503.7 without exception.

3. Areas where specific humidity levels are required to satisfy process needs.

4. Where special pressurization relationships or cross-contamination requirements are such that variable air volume systems are impractical, supply air temperatures shall be reset by representative building load or outside air temperature.

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). ~~((For all Other Occupancies, all gas and oil-fired central heating plants shall have a minimum combustion efficiency of not less than that shown in Table 5-3.))~~

\* 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.

~~((EXCEPTION: These requirements do not apply to equipment used for refrigerated food or florists' and nurseries' coolers.))~~

503.4.5 ~~((Applied HVAC System Components, Electrically Operated, Cooling Mode: HVAC System components, as listed in Table 5-9, whose energy input is entirely electric, shall have an energy efficiency ratio (EER) or a Coefficient of Performance (COP) cooling not less than the values in Table 5-9.))~~ Reserved.

503.4.6 ~~((HVAC System Equipment - Heat Operated, Cooling Mode, Efficiency Limitation, Equipment: Heat operated cooling equipment shall have a COP cooling not less than the values in Table 5-10.))~~ Reserved.

503.5 ~~((Transport Energy:~~

~~503.5.1 All air Systems: The air transport factor for each all air system shall be not less than 5.5. The factor shall be based on design system air flow for constant volume systems. The factor for variable air volume systems may be based on average conditions of operation. Energy for transfer of air through heat recovery devices shall not be included in determining the factor; however, such energy shall be included in the evaluation of the effectiveness of the heat recovery system.~~

$$\text{Air Transport Factor} = \frac{\text{Space-Sensible Heat Removal}^*}{\text{Supply + Return Fan(s) Power Input}^*}$$

\*Expressed in Btu/h or watts

~~503.5.2 Other Systems: Air and water, all water and unitary systems employing chilled, hot, dual temperature or condenser water transport systems to space terminals shall not require greater transport energy (including central and terminal fan power and pump power) than an equivalent all air system providing the same space~~

~~sensible heat recovery and having an air transport factor not less than 5.5.)~~ 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 one hundred percent 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 three thousand five hundred cfm or total cooling capacity is less than ninety thousand 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 one hundred percent 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 one hundred percent 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.

#### 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: Thermostats 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 ((occupancies)) 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 ((Other Types of Buildings or Occupancies: At least one thermostat for regulation of space temperature shall be provided for:~~

- ~~1. Each separate system.~~
  - ~~2. Each separate zone as defined in Chapter 2. As a minimum, each floor of a building shall be considered as a separate zone. In a multistory building where the perimeter system offsets only the transmission losses of the exterior wall, an entire side of uniform exposure may be zoned separately. A readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating and/or cooling input to each floor.))~~
- Reserved.

#### 503.8.3.4 Control Setback and Shut-off:

1. 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 nonuse 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.

~~2. ((Other Buildings and Occupancies. Each HVAC system shall be equipped with a readily accessible, automatic means of shutting off or reducing the energy used for HVAC during periods of non-use~~

~~or alternate use of the building spaces or zones served by the system. The following are examples that meet this requirement:~~

- ~~a. Manually adjustable automatic timing devices.~~
- ~~b. Automatic control systems.)~~ Reserved.

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: 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: 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.

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

503.11 Piping 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 within unitary HVAC equipment.

503.11.1 Other Insulation Thickness: Insulation thickness in Table 5-12 is based on insulation having thermal resistance in the range of 4.0 to 4.6 per inch of thickness on a flat surface at a mean temperature of seventy-five degrees F. Minimum insulation thickness shall be increased for materials having R-values less than 4.0 per inch, or may be reduced for materials having R-values greater than 4.6 per inch.

a. For materials with thermal resistance greater than R = 4.6 per inch, the minimum insulation thickness may be reduced as follows:

$$\frac{4.6 \times (\text{Table 5-12 Thickness})}{\text{Actual Resistance}} = \text{New Minimum Thickness}$$

b. For materials with thermal resistance less than R = 4.0 per inch, the minimum insulation thickness shall be increased as follows:

$$\frac{4.0 \times (\text{Table 5-10 Thickness})}{\text{Actual Resistance}} = \text{New Minimum Thickness}$$

c. Additional insulation with vapor barriers shall be provided to prevent condensation where required by the building official.

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

**WAC 51-11-0505 ((~~Electrical power and lighting~~)) Reserved.**

~~((505.1 General: Electrical distribution and lighting systems shall be designed for efficient distribution and use of electrical energy from the service entrance to and at the points of use as provided herein.~~

~~505.2 Lighting Switching: Switching for building lighting systems shall be designed and installed to permit efficient use of energy and to permit maximum flexibility in the use of the installed lighting. The following mandatory requirements represent the minimum lighting controls to be installed in any building. Additional controls should be provided where deemed appropriate and where the installation of such controls can significantly reduce energy consumption.~~

~~a. All lighting controls, except automatic controls or those for special purpose applications which require trained operators or those which would pose a safety problem or a security hazard, shall be installed so as to be readily accessible to personnel occupying or using the lighting space.~~

~~b. The maximum lighting power that may be controlled from a single switch or automatic control shall not exceed that provided by a twenty ampere circuit loaded to no more than eighty percent.~~

A master control may be installed provided that individual switches retain their capability to function independently.

c. All lighted spaces enclosed by walls or ceiling height partitions and with floor area less than four hundred square feet shall be provided an individual lighting control or an occupant-sensing automatic control.

d. All lighted spaces with floor area greater than four hundred square feet shall be provided with controls to permit reducing the lighting by not more than one half or occupant-sensing automatic controls.

e. All building areas greater than two hundred square feet where natural lighting is available shall be provided with individual controls or daylight or occupant sensing automatic controls which permit control of lights independent of general area lighting. Either individual controls shall be provided for each row of luminaires parallel to a window wall or controls shall be provided to reduce the lighting in at least two steps to not more than one half and to completely off in the natural lighting area. For office and school occupancies, at a minimum, lighting serving a zone within twelve feet of a window wall or the zone between an interior wall and the window wall of less than twelve feet shall comply with this provision. For retail occupancies, at least the row of luminaires nearest the window shall comply with this provision.

f. All display, exhibition, or specialty lighting shall be controlled independently of general area lighting.

g. All exterior building lighting including facade lighting, parking lots, driveways, walkways shall be furnished with automatic controls to reduce or turn off all lights during periods of non-use or daylight hours, except those required for safety and security. Sign lights shall be exempt from this provision.

505.3 Lighting Power Budget: A lighting power budget is the upper limit of the power to be available to provide the lighting needs in accordance with the criteria and calculation procedure specified herein.

The lighting power budget for a building shall be the sum of the power limits computed for all lighted interior and exterior spaces and shall be determined in accordance with the procedures specified in this section.

EXCEPTION: One and two family detached dwellings and the dwelling portion of multifamily buildings are exempt from the requirements of section 505.3.

505.3.1 Budget Development: The installed lighting wattage for the building project shall not exceed the budget level calculated in this section. The budget wattage level shall be the sum of the interior budget calculated and the exterior budget. Lighting wattage includes lamp and ballast wattage.

505.3.2 Building Interiors: The interior lighting budget shall be calculated by multiplying the gross conditioned floor area, in square feet, by the appropriate unit power budget, in watts per square foot, specified in Table 5-13.

~~For special conditions when approved by a building official, calculation based on Illuminating Engineering Society Unit Power Density or similar nationally recognized standards may be used.~~

~~The lighting power budget shall be based on the primary occupancy for which the space within the building is intended. If multiple occupancies are intended, the lighting power budget for each type of occupancy shall be separately calculated and summed to obtain the lighting budget for the interior spaces of the building. If a common circulation area serves multiple occupancies or multiple retail spaces, the lighting power budget for the common circulation area shall be the weighted average of the lighting power budgets for all other areas on that floor. In cases where a lighting plan for only a portion of a building is submitted, the interior lighting budget shall be based on the gross floor area covered by the plan.~~

~~EXCEPTIONS:~~

~~1. Where the following automatic lighting controls are installed, for calculations used to determine code compliance, the installed lighting wattage may be reduced by the following percentages:~~

~~a. For occupant sensing devices, energy savings of thirty percent shall be allowed for any single space up to four hundred ft<sup>2</sup> and enclosed by ceiling height partitions; classrooms, conference rooms, computer rooms, storage areas, corridors, or waiting rooms.~~

~~b. For daylighting controls, energy savings of thirty percent for continuous dimming and twenty percent for stepped controls shall be allowed for any daylit space.~~

~~c. For lumen maintenance controls, energy savings of ten percent shall be allowed for any space.~~

~~d. For daylighting controls with occupant sensing devices, energy savings of forty four percent shall be allowed for any single space up to four hundred ft<sup>2</sup> within daylit spaces, and enclosed by ceiling height partitions.~~

~~e. For occupant sensing devices with lumen maintenance controls, energy savings of thirty seven percent shall be allowed for any single space up to four hundred ft<sup>2</sup> and enclosed by ceiling height partitions.~~

~~505.3.2.1: Lighting for the following applications shall be exempted from inclusion in the calculation of lighting power budgets:~~

~~A. Stage lighting, entertainment, or audiovisual presentations where the lighting is an essential technical element for the function performed.~~

~~B. Lighting for medical and dental tasks.~~

~~C. Lighting in areas specifically designed for visually handicapped people.~~

~~D. For restaurant occupancies, lighting for kitchens and food preparation areas.~~

~~505.3.4 Building Exteriors: The exterior lighting budget shall be calculated by multiplying the building perimeter in feet~~

by 7.5 watts per foot. Lighting for parking structures shall be calculated at 0.3 watts per gross square foot of parking area. An allowance for outdoor surface parking and circulation lighting may be added at 0.05 watts per ft<sup>2</sup> of area. Lighting for signs that are not an integral part of the building shall be exempted from inclusion in these calculations.)

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

WAC 51-11-0528 Equation 4--((Other than Group R Occupancy) Reserved.

TARGET  $U_o$

$$U_o = \frac{U_w A_w + U_F A_F + U_C A_C + F_s P_s}{A_w + A_F + A_C + P_s}$$

Where:

$U_o$  — the target combined thermal transmittance of the gross exterior wall, floor, and roof/ceiling assembly area.

$U_w$  — the thermal transmittance value of the opaque above grade wall area found in Table 5-2.

$A_w$  — opaque above grade wall area.

$U_F$  — the thermal transmittance value of the floor area found in Table 5-2.

$A_F$  — floor area over unconditioned space.

$U_C$  — the thermal transmittance value of the ceiling area found in Table 5-2.

$A_C$  — ceiling area.

$F_s$  — concrete slab component F-value found in Table 5-2.

$P_s$  — lineal ft. of concrete slab perimeter



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

WAC 51-11-0529 Equation 5--(~~Other than Group R Occupancy~~)  
Reserved.

### PROPOSED $U_o$

$$\frac{U_w A_w + U_{BGW} A_{BGW} + U_G A_G + U_F A_F + U_{RC} A_{RC} + U_{CC} A_{CC} + U_D A_D + F_s P_s}{U_o} =$$

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$$P_s \frac{A_w + A_{BGW} + A_G + A_F + A_{RC} + A_{CC} + A_D +$$

Where:

~~$U_o$  = the combined thermal transmittance of the gross exterior wall, floor, and roof/ceiling assembly area.~~

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

~~$U_{BGW}$  = the thermal transmittance value of the below grade opaque wall area.~~

~~$A_{BGW}$  = opaque below grade wall area.~~

~~$A_w$  = opaque wall area.~~

~~$U_G$  = the thermal transmittance of the glazing (window or skylight) area.~~

~~$A_G$  = glazing area, including windows in exterior doors.~~

~~$U_F$  = the thermal transmittance of the floor area.~~

~~$A_F$  = floor area over unconditioned space.~~

~~$U_{RC}$  = the thermal transmittance of the roof/ceiling area.~~

~~$A_{RC}$  = roof/ceiling area.~~

~~$U_{CC}$  = the thermal transmittance of the cathedral ceiling area.~~

~~$A_{CC}$  = cathedral ceiling area.~~

~~$U_D$  = thermal transmittance value of opaque door area.~~

~~$A_D$  = opaque door area.~~

~~$F_S$  = concrete slab component F-factor.~~

~~$P_S$  = lineal ft. of concrete slab perimeter.~~

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

$$\del U_{W1}A_{W1} + U_{W2}A_{W2} + U_{W3}A_{W3} + \dots \text{etc.}$$

WAC 51-11-0531 Table 5-2--Reserved.

~~COMPONENT REQUIREMENTS FOR OTHER THAN GROUP R OCCUPANCIES~~

~~BUILDINGS OF THREE CONDITIONED STORIES OR LESS~~

<del>Zone</del>	<del>Ceilings</del>	<del>Walls (Includes Glazing)</del>	<del>Floors</del>	<del>Slab on Grade<sup>1</sup></del>	
	<del>U<sub>o</sub></del>	<del>U<sub>w</sub></del>	<del>Installed U<sub>o</sub></del>	<del>Installed R-Value</del>	<del>F-Value</del>
<del>I.</del>	<del>0.035</del>	<del>0.25</del>	<del>0.05</del>	<del>7</del>	<del>0.56</del>
<del>II.</del>	<del>0.035</del>	<del>0.20</del>	<del>0.05</del>	<del>10</del>	<del>0.54</del>

~~<sup>1</sup>Insulation shall be water resistant material manufactured for this use.~~

~~BUILDINGS OVER THREE CONDITIONED STORIES~~

<del>Zone</del>	<del>Ceilings</del>	<del>Walls (Includes Glazing)</del>	<del>Floors</del>	<del>Slab on Grade<sup>1</sup></del>	
	<del>U<sub>o</sub></del>	<del>U<sub>w</sub></del>	<del>Installed U<sub>o</sub></del>	<del>Installed R-Value</del>	<del>F-Value</del>
<del>I.</del>	<del>0.08</del>	<del>0.30</del>	<del>0.08</del>	<del>7</del>	<del>0.56</del>
<del>II.</del>	<del>0.06</del>	<del>0.25</del>	<del>0.08</del>	<del>10</del>	<del>0.54</del>

~~<sup>1</sup>Insulation shall be water resistant material manufactured for this use.~~

WAC 51-11-0532 Table 5-3--~~Reserved.~~

~~OTHER THAN GROUP R OCCUPANCY HVAC SYSTEM HEATING EQUIPMENT GAS AND OIL FIRED MINIMUM STEADY STATE COMBUSTION EFFICIENCY~~

<del>Types of Equipment</del>	<del>Percent<sup>1</sup></del>	<del>Percent<sup>2</sup></del>
<del>Furnaces of Capacity of 225,000 Btu/h and less</del>	<del>74</del>	<del>75</del>
<del>All Other Commercial/Industrial Furnace and Boilers</del>		
<del>Boilers of Capacities of 300,000 Btu/h and less</del>		
<del>Gravity central furnaces</del>	<del>69</del>	
<del>All other vented heating equipment</del>	<del>69</del>	

~~<sup>1</sup>Combustion efficiency for furnaces of capacities of 225,000 Btu/h and less and boilers of capacities of 300,000 Btu/h and less shall be tested in accordance with the applicable U.S. Department of Energy furnace test procedures.~~

~~<sup>2</sup>Combustion efficiency of commercial/industrial furnaces and boilers is defined as 100 percent minus stack losses in percent of heat input.~~

~~Stack losses are:~~

~~Loss due to sensible heat in dry flue gas.~~

~~Loss due to incomplete combustion.~~

~~Loss due to sensible and latent heat in moisture formed by combustion of hydrogen in the fuel.~~

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

WAC 51-11-0538 Table 5-9--Reserved.

**MINIMUM EFFICIENCY FOR ELECTRIC HVAC COMPONENTS<sup>1,2</sup>**

**WATER CHILLING PACKAGES**

**CONDENSING MEANS**

TYPE OF COMPONENT	COMPRESSOR TYPE	AIR		WATER		EVAPORATIVE	
		EER	COP	EER	COP	EER	COP
Condenser Included	Centrifugal or rotary	8.00	2.34	13.80	4.04		
	Reciprocating	8.40	2.36	12.00	3.51		
	Condenserless Reciproc.	9.90	2.90	12.00	3.51		

Compressor and condenser units 65,000 Btu/hr (19,000 watts) Positive and over <sup>2</sup> displacement		9.50	2.78	12.50	3.66	12.50	3.66
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**HYDRONIC HEAT PUMPS**

Water source under 65,000 Btu/hr (19,000 watts)	Centrifugal or rotary		9.00		2.64		
Water source 65,000 Btu/hr (19,000 watts) and over	Centrifugal or rotary		9.40		2.75		

<sup>1</sup>-When tested at the standard rating conditions specified in Table 5-6.

<sup>2</sup>-Ratings in accordance with Standard RS 14 as applicable.

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

WAC 51-11-0539 Table 5-10--Reserved.

~~HVAC SYSTEM HEAT OPERATED COOLING EQUIPMENT~~

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<del>HEAT SOURCE</del>	<del>MINIMUM COP</del>
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<del>Direct Fired ( gas, oil )</del>	<del>0.48</del>
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<del>Indirect Fired ( steam, hot water )</del>	<del>0.68</del>
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<del>Minimum COP</del>	<del>Net Cooling Output</del>
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~~Total heat input<sup>1</sup>~~

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~~<sup>1</sup>-electrical auxiliary inputs excluded~~

WAC 51-11-0540 Table 5-11.

**INSULATION OF DUCTS**

<b>DUCT LOCATION</b>	<b>CLIMATE ZONE</b>	<b>INSULATION TYPES MECHANICALLY COOLED</b>	<b>INSULATION TYPES HEATING ONLY</b>	<b>GROUP R OCCUPANCY HEATING OR COOLING DUCTS</b>
On roof or on exterior of building	I	C, V <sup>2</sup> and W	C and W	E and W
	H	D, V <sup>2</sup> and W	D and W	D and W
Attic, garage, crawlspace, in walls <sup>1</sup> , in floor/ceiling <sup>1</sup>	I	B and V <sup>2</sup>	B	E
	H	C and V <sup>2</sup>	C	E
Within the conditioned space or in heated basements		None Required	None Required	None Required
In cement slab or in ground		A	B	B

Note: Where ducts are used for both heating and cooling, the minimum insulation shall be as required for the most restrictive condition.

<sup>1</sup>— Insulation may be omitted on that portion of a duct which is located within a wall or floor ceiling space where both sides of this space are exposed to conditioned air and where this space is not ventilated or otherwise exposed to unconditioned air.

<sup>2</sup>— Vapor barriers shall be installed on conditioned air supply ducts in geographic areas where the average of the July, August, and September mean dewpoint temperature exceeds 60°F.

~~INSULATION TYPES: Minimum densities and out of package thickness:~~

- ~~A. 0.5 inch 1.5 to 2 lb/cu. ft. duet liner, mineral or glass fiber blanket or equivalent to provide an installed total thermal resistance of at least R 2.~~
- ~~B. 2 inch 0.60 lb/cu. ft. mineral or glass fiber blanket 1.5 inch 1.5 to 2 lb/cu. ft. duet liner, mineral or glass fiber blanket. 1.5 inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R 5.~~
- ~~C. 3 inch 0.60 lb/cu. ft. mineral or glass fiber blanket 2 inch 1.5 to 2 lb/cu. ft. duet liner, mineral or glass fiber blanket. 2 inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R 7.~~
- ~~D. 4 inch 0.60 lb/cu. ft. mineral or glass fiber blanket 3 inch 1.5 to 2 lb/cu. ft. duet liner, mineral or glass fiber blanket. 3 inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R 10.~~
- ~~E. 3.5 inch 0.60 lb/cu.ft. mineral or glass fiber blanket, 2.5 inch 1.5 to 2 lb/cu. ft. duet liner, mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R 8.~~
- ~~V. Vapor barrier, with perm rating not greater than 0.5 perm, all joints sealed.~~
- ~~W. Approved weatherproof barrier.~~



**TABLE 5-11  
INSULATION OF DUCTS**

<u>DUCT LOCATION</u>	<u>CLIMATE ZONE</u>	<u>GROUP R OCCUPANCY HEATING OR COOLING DUCTS</u>
<u>On roof or on exterior of building</u>	<u>I</u> <u>II</u>	<u>E and W</u> <u>D and W</u>
<u>Attic, garage, crawl space, in walls<sup>1</sup>, in floor/ceiling<sup>1</sup></u>	<u>I</u> <u>II</u>	<u>E</u> <u>E</u>
<u>Within the conditioned space or in heated basement</u>		<u>None Required</u>
<u>In cement slab or in ground</u>		<u>B</u>

Note: Where ducts are used for both heating and cooling, the minimum insulation shall be as required for the most restrictive condition.

<sup>1</sup> Insulation may be omitted on that portion of a duct which is located within a wall or floor-ceiling space where both sides of this space are exposed to conditioned air and where this space is not ventilated or otherwise exposed to unconditioned air.

<sup>2</sup> Vapor barriers shall be installed on conditioned air supply ducts in geographic areas where the average of the July, August, and September mean dewpoint temperature exceeds 60°F.

INSULATION TYPES: Minimum densities and out-of-package thickness.

- A. 0.5-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket or equivalent to provide an installed total thermal resistance of at least R-2.
- B. 2-inch 0.60 lb/cu. ft. mineral or glass fiber blanket 1.5-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket. 1.5-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-5.
- C. 3-inch 0.60 lb/cu. ft. mineral or glass fiber blanket 2-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket. 2-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-7.
- D. 4-inch 0.60 lb/cu. ft. mineral or glass fiber blanket 3-inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber blanket. 3-inch 3 to 7 lb/cu. ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-10.
- E. 3.5 inch 0.60 lb/cu.ft. mineral or glass fiber blanket, 2.5 inch 1.5 to 2 lb/cu. ft. duct liner, mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-8.
- V. Vapor barrier, with perm rating not greater than 0.5 perm, all joints sealed.
- W. Approved weatherproof barrier.

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

WAC 51-11-0542 Table 5-13--Reserved.

LIGHTING POWER BUDGET<sup>1</sup>

<u>GROUP</u> <u>OCCUPANCY</u>	<u>DESCRIPTION</u>	<u>LIGHTING</u> <u>POWER BUDGET<sup>1</sup></u> <u>(Watts/ft<sup>2</sup>)</u>
A	Assembly w/stage	
	Stage lighting	1.1
	Assembly w/o stage; other than B and E	Exempt
B	Gasoline service station	1.7
	Storage garages	0.3
	Office buildings	1.7
	Wholesale stores	2.0
	Police and fire stations	1.7
	Retail stores:	
	less than 6000 ft <sup>2</sup>	4.0
	6000 to 20,000 ft <sup>2</sup>	3.0
	over 20,000 ft <sup>2</sup>	2.0
	Drinking and dining establishments	1.85
	Food preparation task light	Exempt
	Aircraft hangars—storage	0.7
	Process plants <sup>4</sup>	1.0
	Factories and work shops <sup>4</sup>	1.7
Storage structures	0.7	
E	Schools and daycare centers	1.7
	Audio-visual presentation lighting	Exempt
H	Storage structures	0.7
	Handling areas	1.7
	Paint shops	2.5
	Auto repair shops	1.7
	Aircraft repair hangars	1.7

I	Institutions	1.7
	Administrative support areas	1.7
	Diagnostic, treatment, food service task lighting	Exempt
R	Dwelling units	Exempt
	Food preparation task lighting	Exempt

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~~<sup>1</sup> Watts/ft<sup>2</sup> of room may be increased by two percent per foot of height above 20 feet.~~

~~<sup>2</sup> Emergency exit lighting is exempt from interior lighting budget.~~

~~<sup>3</sup> Lighting that is part of machines or equipment is exempt from this budget.~~

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

**WAC 51-11-0605** (~~(Building envelope requirements for other than Group R occupancies)~~) Reserved.

~~((605.1 Opaque Envelope Criteria:—Roof/ceilings, exterior walls, floors over unconditioned space, below grade walls, and slab on grade floors enclosing heated spaces shall be insulated to not less than the nominal R value specified for roof/ceilings, exterior walls, floors over unconditioned space, below grade walls, and slab on grade floors, respectively, in Table 6-7.—Roof/ceilings enclosing mechanically cooled spaces shall be insulated to not less than the nominal R value specified for roof/ceilings in Table 6-7.~~

~~605.2 Glazing Criteria: All glazing shall be, at a minimum, double glazing. Insulating glass with at least one half inch air space or approved storm sash will be considered as complying. The total glazing area shall not exceed the percentage of gross exterior wall area specified in Table 6-7.~~

~~EXCEPTION:—Single glazing in doors may be installed provided that the glazing area is doubled for the purpose of demonstrating compliance with the glazing area requirements.~~

~~605.3 Air Leakage: All buildings shall comply with the air leakage requirement of section 502.4.)~~

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

**WAC 51-11-0606** (~~(Building mechanical systems requirements for other than Group R occupancies)~~) Reserved. (~~(All building mechanical systems shall comply with the requirements of section 503.)~~)

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

**WAC 51-11-0607** (~~(Service water heating requirement for other than Group R occupancies)~~) Reserved. (~~(All service water heating systems shall comply with the requirements of section 504.)~~)

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

WAC 51-11-0608 (~~Electrical power and lighting requirements for other than Group R occupancies~~) Reserved. ((All electrical power and lighting systems shall comply with the requirements of section 505.))

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

WAC 51-11-0631 Table 6-7--Reserved.

~~TABLE 6-7 OTHER THAN GROUP R OCCUPANCIES PRESCRIPTIVE REQUIREMENTS~~

<del>COMPONENT</del>	<del>ZONE I</del>	<del>ZONE II</del>
<del>SPACE CONDITIONING SYSTEM TYPE</del>	<del>ANY</del>	<del>ANY</del>
<del>ROOF/CEILINGS</del>	<del>R 30</del>	<del>R 30</del>
<del>EXTERIOR WALLS</del>	<del>R 11</del>	<del>R 11</del>
<del>FLOORS OVER UNCONDITIONED SPACE</del>	<del>R 11</del>	<del>R 11</del>
<del>BELOW GRADE WALLS</del>	<del>R 4</del>	<del>R 5</del>
<del>SLAB ON GRADE FLOORS<sup>1</sup></del>	<del>R 7</del>	<del>R 10</del>
<del>GLAZING TYPE</del>	<del>Double<sup>2</sup></del>	<del>Double<sup>2</sup></del>
<del>MAXIMUM TOTAL GLAZING AREA (% of Gross Exterior Wall Area)</del>	<del>32%</del>	<del>22%</del>

~~<sup>1</sup> Insulation shall be a water resistant material, manufactured for its intended use, and installed to manufacturer's specifications.~~

~~<sup>2</sup> 'Double' denotes a minimum air space between glazings of 1/2 inch.~~

CHAPTER 11  
ADMINISTRATION AND ENFORCEMENT

NEW SECTION

**WAC 51-11-1100 Title.** Chapters 11 through 20 of this Code shall be known as the "Washington State Nonresidential Energy Code" and may be cited as such; and will be referred to hereafter as "this Code."

NEW SECTION

**WAC 51-11-1110 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. 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.

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. 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.

NEW SECTION

**WAC 51-11-1120 Scope.** This Code sets forth minimum requirements for the design of new or altered buildings and structures or portions thereof that provide facilities or shelter for public assembly, educational, business, mercantile, institutional, storage, factory, and industrial occupancies by regulating their exterior envelopes and the selection of their HVAC, service water heating, electrical distribution and illuminating systems and equipment for efficient use and conservation of energy.

NEW SECTION

**WAC 51-11-1130 Application to existing buildings.** Additions, alterations or repairs, changes of occupancy or use, and historic buildings that do not comply with the requirements for new buildings, shall comply with the requirements in Sections 1130 through 1134.

Exception: The building official may approve designs of alterations or repairs which do not fully conform with all of the requirements of Sections 1130 through 1134 where in the opinion of the building official full compliance is physically impossible and/or economically impractical and the alteration or repair improves the energy efficiency of the building.

In no case shall energy code requirements be less than those requirements in effect at the time of the initial construction of the building.

#### NEW SECTION

**WAC 51-11-1131 Additions to existing buildings.** Additions to existing buildings or structures may be constructed 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 may be approved provided that improvements are made to the existing building to compensate for any deficiencies in the new addition. Compliance shall be demonstrated by either systems analysis per Section 1141.4 or component performance calculations per Sections 1330 through 1334. The nonconforming addition and upgraded, existing building shall have an energy budget or target UA and SHGC that are less than or equal to the unimproved existing building, with the addition designed to comply with this Code.

#### NEW SECTION

**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. 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 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 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.

#### NEW SECTION

**WAC 51-11-1133 Change of occupancy or use.** Changes of occupancy or use shall comply with the following requirements:

- a. Any unconditioned space that is altered to become conditioned space shall be required to be brought into full compliance with this Code.
- b. Any Group R occupancy which is converted to other than a Group R occupancy shall be required to comply with all of the provisions of Sections 1130 through 1132 of this Code.



NEW SECTION

**WAC 51-11-1134 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.

NEW SECTION

**WAC 51-11-1140 Enforcement.** The building official shall have the power to render interpretations of this code and to adopt and enforce rules and supplemental regulations in order to clarify the application of its provisions. Such interpretations, rules and regulations shall be in conformance with the intent and purpose of this Code. Fees may be assessed for enforcement of this Code and shall be as set forth in the fee schedule adopted by the jurisdictions.

NEW SECTION

**WAC 51-11-1141 Plans and specifications.**

1141.1 General: If required by the building official, plans and specifications shall be submitted in support of an application for a building permit. If required by the building official, plans and specifications shall be stamped and authenticated by a registered design professional currently licensed in the state of Washington. All plans and specifications, together with supporting data, shall be submitted to the building official prior to issuance of a building permit.

1141.2 Details: The plans and specifications shall show in sufficient detail all pertinent data and features of the building and the equipment and systems as herein governed including, but not limited to: Design criteria; exterior envelope component materials, U-factors of the envelope systems, R-values of insulating materials; U-factors and shading coefficients of glazing; area weighted U-factor calculations; efficiency, economizer, size and type of apparatus and equipment; fan system horsepower; equipment and systems controls; lighting fixture schedule with wattages and controls narrative; and other pertinent data to indicate compliance with the requirements of this Code.

1141.3 Alternate Materials and Method of Construction: The provisions of this Code are not intended to prevent the use of any material, method of construction, design or insulating system not

specifically prescribed herein, provided that such construction, design or insulating system has been approved by the building official as meeting the intent of this Code. The building official may approve any such alternate provided the proposed alternate meets or exceeds the provisions of this Code and that the material, method, design or work offered is for the purpose intended, at least the equivalent of that prescribed in this Code, in quality, strength, effectiveness, fire-resistance, durability, safety, and energy efficiency. The building official may require that sufficient evidence of proof be submitted to substantiate any claims that may be made regarding performance capabilities.

1141.4 Systems Analysis Approach for the Entire Building: In lieu of using Chapters 12 through 20, compliance may be demonstrated using the systems analysis option in RS-29. When using systems analysis, the proposed building shall provide equal or better conservation of energy than the standard design as defined in RS-29. If required by the building official, all energy comparison calculations submitted under the provisions of RS-29 shall be stamped and authenticated by an engineer or architect licensed to practice by the state of Washington.

#### NEW SECTION

##### **WAC 51-11-1142 Materials and equipment.**

1142.1 Identification: All materials and equipment shall be identified in order to show compliance with this Code.

1142.2 Maintenance Information: Maintenance instructions shall be furnished for any equipment which requires preventive maintenance for efficient operation. Required regular maintenance actions shall be clearly stated and incorporated on a readily accessible label. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

#### NEW SECTION

##### **WAC 51-11-1143 Inspections.**

1143.1 General: All construction or work for which a permit is required shall be subject to inspection by the building official and all such construction or work shall remain accessible and exposed for inspection purposes until approved by the building official. No work shall be done on any part of the building or structure beyond the point indicated in each inspection without first obtaining the approval of the building official.

1143.2 Required Inspections: The building official, upon notification, shall make the inspection required in this Section, in addition to or as part of those inspections required in Section

305(e) of the Uniform Building Code. Inspections may be conducted by special inspection pursuant to Section 306(b) and 306(c) of the Uniform Building Code. Where applicable, inspections shall include at least:

1143.2.1 Envelope

a. Wall Insulation Inspection: To be made after all wall insulation and air vapor retarder sheet or film materials are in place, but before any wall covering is placed.

b. Glazing Inspection: To be made after glazing materials are installed in the building.

c. Exterior Roofing Insulation: To be made after the installation of the roof insulation, but before concealment.

d. Slab/Floor Insulation: To be made after the installation of the slab/floor insulation, but before concealment.

1143.2.2 Mechanical

a. Mechanical Equipment Efficiency and Economizer: To be made after all equipment and controls required by this Code are installed and prior to the concealment of such equipment or controls.

b. Mechanical Pipe and Duct Insulation: To be made after all pipe and duct insulation is in place, but before concealment.

1143.2.3 Lighting and Motors

a. Lighting Equipment and Controls: To be made after the installation of all lighting equipment and controls required by this Code, but before concealment of the lighting equipment.

b. Motor Inspections: To be made after installation of all equipment covered by this Code, but prior to concealment.

1143.3 Re-inspection: The building official may require a structure to be re-inspected. A re-inspection fee may be assessed for each inspection or re-inspection when such portion of work for which inspection is called is not complete or when corrections called for are not made.

NEW SECTION

**WAC 51-11-1144 Violations.** It shall be a violation of this Code for any person, firm, or corporation to erect or construct any building, or remodel or rehabilitate any existing building or structure in the state, or allow the same to be done, contrary to any of the provisions of this Code.

NEW SECTION

**WAC 51-11-1150 Conflicts with other codes.** In case of conflicts among Codes enumerated in RCW 19.27.031 (1), (2), (3) and (4) and this Code, the first named Code shall govern. The duct insulation requirements in this Code or a local jurisdiction's

energy code, whichever is more stringent, supersede the requirements in the Uniform Mechanical Code.

Where, in any specific case, different sections of this Code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable.

#### NEW SECTION

##### **WAC 51-11-1160 Severability and liability.**

1161 Severability: If any provision of this Code or its application to any person or circumstance is held invalid, the remainder of this Code or the application of the provision to other persons or circumstances is not affected.

1162 Liability: Nothing contained in this Code is intended to be nor shall be construed to create or form the basis for any liability on the part of any city or county or its officers, employees or agents for any injury or damage resulting from the failure of a building to conform to the provisions of this Code.

## **CHAPTER 12 DEFINITIONS**

#### NEW SECTION

**WAC 51-11-1201 Scope.** The following definitions will apply to Chapters 11 through 20.

#### NEW SECTION

**WAC 51-11-1210 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.

**AAMA:** American Architectural Manufacturers Association.

**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 2007.2 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 2005.2 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 finished grade or which extend two feet or less above the finish grade.

**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:** 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.

**CONDITIONED FLOOR AREA:** (See **Gross Conditioned Floor Area**.)

**CONDITIONED SPACE.** A cooled space, heated space (fully heated), heated space (semi-heated), or indirectly conditioned space.

**COOLED SPACE:** 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 degrees 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.

**DESIGN COOLING CONDITIONS:** The cooling outdoor design temperature from the 0.5 percent 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 percent column for winter from the Puget Sound Chapter of ASHRAE publication "Recommended Outdoor Design Temperatures, Washington State, ASHRAE."

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

**DOOR:** 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.

**DWELLING UNIT:** See the Washington State Building Code.

**EER - ENERGY EFFICIENCY RATIO:** The ratio of 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/h•ft<sup>2</sup>•°F.

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

**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.

**GLAZING AREA:** Total area of the glazing measured using the rough opening, and including the glazing, sash, and frame. For doors where the daylight opening area is less than fifty percent 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; includes opaque wall, 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, vertical glazing areas, 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:** 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):** An enclosed space within a building, including adjacent connected spaces separated by an un-insulated 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 degrees 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 un-insulated 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 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.)

**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.**)

**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 Uniform 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 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 a building.

**OVERHEAD GLAZING.** A glazing surface that has a slope of less than sixty degrees 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.)

**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.

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

**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).

**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 FLOOR:** A floor assembly, on grade or below, containing heated pipes, ducts, or electric heating cables that constitute a floor or portion thereof for 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 (excluding minerals) 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:** (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 non-opaque 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 26 of Standard RS-27, listed in **Chapter 17** of this Code.

**SHALL:** Denotes a mandatory Code requirement.

**SKYLIGHT:** (See **Overhead Glazing.**)

**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.

**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.

**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.**)

**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/h·ft<sup>2</sup>·°F).

**THERMAL RESISTANCE (R):** The reciprocal of thermal conductance (h·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/h·ft<sup>2</sup>·°F).

**THERMAL TRANSMITTANCE, OVERALL (U<sub>o</sub>):** The overall (average) heat transmission of a gross area of the exterior building envelope (Btu/h·ft<sup>2</sup>·°F). The U<sub>o</sub>-factor applies to the combined effect of the time rate of heat flows through the various parallel paths, such as 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.)

**UNCONDITIONED SPACE:** Space within a building that is not a conditioned space. (See Conditioned Space).

**UNIFORM BUILDING CODE:** The Washington State Uniform Building Code as modified by the Washington State Building Code Council.

**UNIFORM MECHANICAL CODE:** The Washington State Uniform Mechanical Code as modified by the Washington State Building Code Council.

**UNIFORM PLUMBING CODE (UPC):** The Washington State Uniform Plumbing Code as modified by the Washington State Building Code Council.

**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 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 sixty degrees 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.

**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.

## CHAPTER 13 BUILDING ENVELOPE

NEW SECTION

**WAC 51-11-1301 Scope.** Conditioned buildings or portions thereof shall be constructed to provide the required thermal performance of the various components according to the requirements of this chapter. Unless otherwise approved by the building official, all spaces shall be assumed to be at least semi-heated.

Exception:

1. Greenhouses isolated from any conditioned space and not intended for occupancy.
2. As approved by the building official, spaces not assumed to be at least semi-heated.
3. Unconditioned Group M occupancy accessory to Group R occupancy.

NEW SECTION

**WAC 51-11-1302 Space heat type.** For the purpose of determining building envelope requirements, the following two categories comprise all space heating types:

**Electric Resistance:** Space heating systems which use electric resistance elements as the primary heating systems including baseboard, radiant, and forced air units where the total electric resistance heat capacity exceeds one watt per square foot of the gross conditioned floor area.

**Exception:** Heat pumps and terminal electric resistance heating in variable air volume distribution systems.

**Other:** All other space heating systems including gas, solid fuel, oil, and propane space heating systems and those systems listed in the exception to electric resistance.

NEW SECTION

**WAC 51-11-1303 Climate zones.** All buildings shall comply with the requirements of the appropriate climate zone as defined herein.

**ZONE 1:** Climate Zone 1 shall include all counties not included in Climate Zone 2.

**ZONE 2:** Climate Zone 2 shall include: Adams, Chelan, Douglas, Ferry, Grant, Kittitas, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, and Whitman counties.

NEW SECTION

**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 RS-31 by a certified independent agency licensed by the National Fenestration Rating Council (NFRC). Compliance shall be based on Model Size AA or BB. 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.

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 27 of RS-27 or from the manufacturer's test data.

NEW SECTION

**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. Roof/ceiling assemblies without a vented airspace, 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.

#### NEW SECTION

##### **WAC 51-11-1314 Air leakage.**

1314.1 Building Envelope: The requirements of this section shall apply to building elements separating conditioned from unconditioned spaces. 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 shall be sealed, caulked, gasketed, or weatherstripped to limit air leakage.

1314.2 Glazing and Doors: Doors and operable glazing separating conditioned from unconditioned space shall be weatherstripped. Fixed windows shall be tight fitting with glass retained by stops with sealant or caulking all around.

Exception: Openings that are required to be fire resistant.

1314.3 Building Assemblies Used as Ducts or Plenums: Building assemblies used as ducts or plenums shall be sealed, caulked, and gasketed to limit air leakage.

#### NEW SECTION

##### **WAC 51-11-1320 Prescriptive building envelope option.**

#### NEW SECTION

**WAC 51-11-1321 General.** This section establishes building envelope design criteria in terms of prescribed requirements for building construction.

NEW SECTION

**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.

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.

NEW SECTION

**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 street level story of a retail occupancy provided the glazing is double-glazed with a minimum 1/2 inch airspace and does not exceed 75 percent of the gross exterior wall area of the street level story which does not exceed 20 feet in height. 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 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 vertical glazing shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and U-factor. The area-weighted average solar heat gain coefficient of overhead glazing shall not be greater than that specified in Tables 13-1 or 13-2 for the appropriate area and U-factor.

#### NEW SECTION

**WAC 51-11-1330 Component performance building envelope option.**

#### NEW SECTION

**WAC 51-11-1331 General.** Buildings or structures whose design heat loss rate ( $UA_p$ ) and solar heat gain coefficient ( $SHGC_p$ ) are less than or equal to the target heat loss rate ( $UA_t$ ) and solar heat gain coefficient ( $SHGC_t$ ) 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 RS-9 with the following additional requirements:

1. Only the Exterior Wall Requirements portion of RS-32 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 RS-29.

NEW SECTION

**WAC 51-11-1332 Component U-factors.** The U-factors for typical construction assemblies are included in Chapter 20. These values shall be used for all calculations. Where proposed construction assemblies are not represented in Chapter 20, values shall be calculated in accordance with Chapters 19-27 in RS-27 listed in Chapter 17, using the framing factors listed in Chapter 20. For envelope assemblies containing metal framing, the U-factor shall be determined by one of the following methods:

1. Results of laboratory measurements according to acceptable methods of test.
2. Standard RS-25, listed in Chapter 17, 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 22 of RS-27, listed in Chapter 17.
4. Effective framing/cavity R-values as provided in Table 20-5A.

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.

NEW SECTION

**WAC 51-11-1333 UA Calculations.** The target  $UA_t$  and the proposed  $UA_p$  shall be calculated using Equations 13-1 and 13-2 and the corresponding areas and U-factors from Table 13-1 or 13-2. For the target  $UA_t$  calculation, the overhead glazing shall be located in roof/ceiling area and the remainder of the glazing allowed per Table 13-1 or 13-2 shall be located in the wall area.

**CHAPTER 14  
BUILDING MECHANICAL SYSTEMS**

NEW SECTION

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

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

NEW SECTION

**WAC 51-11-1402 Mechanical ventilation.** The minimum requirements for ventilation shall comply with the Washington State Ventilation and Indoor Air Quality Code (chapter 51-13 WAC).

NEW SECTION

**WAC 51-11-1410 General requirements.** The building mechanical system shall comply with Sections 1411 through 1415, Sections 1440 through 1442 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.
- 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
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	
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
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

NEW SECTION

**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.

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: Equipment whose listed principal function is service water heating and which is used to provide additional functions (e.g., space heating) as part of a combination system, shall comply with minimum performance requirements for the principal function category.

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.

#### NEW SECTION

##### **WAC 51-11-1413 Air Economizers.**

1413.1 Operation: Air economizers shall be of automatically modulating outside and return air dampers to provide 100 percent of the design supply air as outside air to reduce or eliminate the need for mechanical cooling.

1413.2 Control: Air economizers shall be controlled by a control system capable of determining if outside air can meet part or all of the building's cooling loads.

1413.3 Integrated Operation: Building Heating Energy: Air economizers shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load. Controls shall not preclude the economizer operation when mechanical cooling is required simultaneously.

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

#### NEW SECTION

##### **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.

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

NEW SECTION

**WAC 51-11-1420 Simple systems (packaged unitary equipment).**

NEW SECTION

**WAC 51-11-1421 System type.** To qualify as a simple system, systems shall be one of the following:

- a. Air cooled, constant volume packaged equipment, which provide heating, cooling or both, and require only external connection to duct work and energy services.
- b. Air cooled, constant volume split systems, which provide heating, cooling or both, with cooling capacity of 54,000 Btu/h or less.
- c. Heating only systems which have a capacity of less than 5,000 cfm or which have a minimum outside air supply of less than 70 percent of the total air circulation.

All other systems shall comply with Sections 1430 through 1438.

NEW SECTION

**WAC 51-11-1422 Controls.** In addition to the control requirements in Section 1412, where separate heating and cooling equipment serve the same temperature zone, thermostats shall be interlocked to prevent simultaneous heating and cooling.

NEW SECTION

**WAC 51-11-1423 Economizers.** Economizers meeting the requirements of Section 1413 shall be installed on packaged roof top 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.



NEW SECTION

**WAC 51-11-1424 Separate air distribution systems.** Zones with special process temperature requirements and/or humidity requirements shall be served by separate air distribution systems from those serving zones requiring only comfort conditions.

NEW SECTION

**WAC 51-11-1430 Complex systems.**

NEW SECTION

**WAC 51-11-1431 System type.** All systems not qualifying for Sections 1420 through 1424 (Simple Systems), including field fabricated and constructed of system components, shall comply with Sections 1430 through 1438. Simple systems may also comply with Sections 1430 through 1438.

1431.1 Field-Assembled Equipment and Components: Field-assembled equipment and components from more than one manufacturer shall show compliance with this section and Section 1411 through calculations of total on-site energy input and output. The combined component efficiencies as measured per Section 1411.2, shall be in compliance with the requirements of Section 1411.1.

Total on-site energy input to the equipment shall be determined by combining the energy inputs to all components, elements, and accessories such as compressor(s), internal circulating pump(s), purge devices, viscosity control heaters, and controls.

NEW SECTION

**WAC 51-11-1432 Controls.**

1432.1 Setback and Shut-off: Systems that serve zones with different uses, as defined in Table 15-1

1. shall be served by separate systems, or
2. shall include isolation devices and controls to shut off or set back the supply of heating and cooling to each zone independently.

Exception: Isolation or separate systems are not required for zones expected to operate continuously or expected to be inoperative only when all other zones are inoperative.

## 1432.2 Systems Temperature Reset Controls

1432.2.1 Air Systems for Multiple Zones: Systems supplying heated or cooled air to multiple zones shall include controls which automatically reset supply air temperatures by representative building loads or by outside air temperature. Temperature shall be reset by at least 25 percent of the design supply-air-to-room-air temperature difference.

Exception: Where specified humidity levels are required to satisfy process needs, such as computer rooms or museums.

1432.2.2 Hydronic Systems: Systems with a design capacity of 600,000 Btu/h or greater supplying heated water to comfort conditioning systems shall include controls which automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature. Temperature shall be reset by at least 25 percent of the design supply-to-return water temperature differences.

### NEW SECTION

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

- a. Packaged roof top 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.

#### 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 soil and internal load shall be the same as those used for peak load calculations, except for the outside air temperatures.

#### NEW SECTION

**WAC 51-11-1434 Separate air distribution systems.** Zones with special process temperature requirements and/or humidity requirements shall be served by separate air distribution systems from those serving zones requiring only comfort conditions; or shall include supplementary control provisions so that the primary systems may be specifically controlled for comfort purposes only.

Exception: Zones requiring only comfort heating or comfort cooling that are served by a system primarily used for process temperature and humidity control provided that:

1. The total supply air to those comfort zones is no more than 25 percent of the total system supply air, or
2. The total conditioned floor area of the zones is less than 1,000 ft<sup>2</sup>.

#### NEW SECTION

**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.

Exceptions:

1. 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.

#### NEW SECTION

**WAC 51-11-1436 Heat recovery.** Fan systems which have both a capacity of 5,000 cfm or greater and which have a minimum outside air supply of 70 percent or greater of the total air circulation shall have a heat recovery system with at least 50 percent recovery effectiveness. Fifty percent heat recovery effectiveness shall mean an increase in the outside air supply temperature at design heating conditions of one half the difference between the outdoor design air temperature and 65 degrees F. Provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1433. Heat recovery energy may be provided from any site-recovered or site-solar source.

#### Exceptions:

1. Laboratory systems equipped with both variable air volume supply and variable air volume or two-speed exhaust fume hoods.
2. Systems serving spaces heated to less than 60 degrees F.
3. Systems which can be shown to use as much energy with the addition of heat recovery equipment as without it.
4. Systems exhausting toxic, flammable, paint exhaust or corrosive fumes making the installation of heat recovery equipment impractical.
5. Type I commercial kitchen hoods.

#### NEW SECTION

**WAC 51-11-1437 Electric motor efficiency.** Design A & B squirrel-cage, T-frame induction permanently wired polyphase motors of 1 hp or more having synchronous speeds of 3,600, 1,800 and 1,200 rpm shall have a nominal full-load motor efficiency no less than the corresponding values for energy efficient motors provided in Table 14-4.

#### Exceptions:

1. Motors used in systems designed to use more than one speed of a multi-speed motor.
2. Motors used as a component of the equipment meeting the minimum equipment efficiency requirements of Section 1411 and

- Tables 14-1 and 14-2 provided that the motor input is included when determining the equipment efficiency.
3. Motors that are an integral part of specialized process equipment.
  4. Where the motor is integral to a listed piece of equipment for which no complying motor has been approved.

NEW SECTION

**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 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 51-11-1440 Service water heating.**

NEW SECTION

**WAC 51-11-1441 Water heater installation.** Electric water heaters in unconditioned spaces or on concrete floors shall be placed on an incompressible, insulated surface with a minimum thermal resistance of R-10.

NEW SECTION

**WAC 51-11-1442 Shut off controls.** Systems designed to maintain usage temperatures in hot water pipes, such as circulating hot water systems or heat traced pipes shall be equipped with automatic time switches or other controls to turn off the system during periods of non-use.

NEW SECTION

**WAC 51-11-1450 Heated pools.**

NEW SECTION

**WAC 51-11-1451 General.** The requirements in this section apply to "general and limited use pools" as defined in the Washington Water Recreation Facilities Regulations (chapter 246-260 WAC).

NEW SECTION

**WAC 51-11-1452 Pool water heaters.** Pool water heaters using electric resistance heating as the primary source of heat are prohibited for pools over 2,000 gallons.

NEW SECTION

**WAC 51-11-1453 Controls.** 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 65 degrees F.

**CHAPTER 15  
LIGHTING AND MOTORS**

NEW SECTION

**WAC 51-11-1501 Scope.** Interior and exterior lighting and electric motors shall comply with the requirements of this chapter.

NEW SECTION

**WAC 51-11-1510 General requirements.** Lighting and motors shall comply with Sections 1511 through 1513. Lighting systems shall comply with one of the following paths:

- a. Prescriptive Standards:  
Interior Section 1521, or  
Exterior Section 1522.
- b. Component Performance:  
Interior Section 1531, or  
Exterior Section 1532.
- c. Systems Analysis. See Section 1141.4.

The compliance path selected for interior and exterior lighting need not be the same. However, interior and exterior lighting cannot be traded.

**Figure 15A**  
**Lighting and Motor Compliance Options**

Section Number	Subject	Prescriptive Option	Lighting Power Allowance Option	Systems Analysis Option
1510	General Requirements	X	X	X
1511	Electric Motors	X	X	X
1512	Exempt Lighting	X	X	X
1513	Lighting Controls	X	X	X
1520	Prescriptive Lighting Option	X		
1521	Prescriptive Interior Lighting Requirements	X		
1522	Prescriptive Exterior Lighting Requirements	Sec. 1532		
1530	Lighting Power Allowance Option		X	
1531	Interior Lighting Power Allowance		X	
1532	Exterior Lighting Power Allowance		X	
RS-29	Systems Analysis			X

NEW SECTION

**WAC 51-11-1511 Electric motors.** All permanently wired polyphase motors of 1 hp or more, which are not part of an HVAC system, shall comply with Section 1437.

Exceptions:

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

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

#### NEW SECTION

##### **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 safety 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.

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 for signs, and ballasted lighting 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, nonretail displays, portable plug in display fixtures, and show case lighting.
8. Exterior lighting for public monuments.



NEW SECTION

**WAC 51-11-1520 Prescriptive lighting option.**

NEW SECTION

**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 one- or two- lamp (but not three- or more lamp) non-lensed, fluorescent fixtures fitted with type T-5, T-6, T-8 or PL type lamps from 5 to 50 watts and electronic ballasts.

Exception: Up to a total of 5 percent of installed lighting fixtures need not be ballasted and may use any type of lamp.

NEW SECTION

**WAC 51-11-1522 Prescriptive exterior lighting requirements.**  
See section 1532.

NEW SECTION

**WAC 51-11-1530 Component performance lighting 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 the maximum of actual luminaire wattage or 50 watts per lineal foot of track.

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

NEW SECTION

**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 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.

**CHAPTER 16  
(RESERVED)**

**CHAPTER 17  
STANDARDS**

NEW SECTION

**WAC 51-11-1701 Scope.** The following standards will apply to Chapters 11 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.

CODE  
STANDARD

NO.

TITLE AND SOURCE

RS-1	through RS-8 ( <b>Reserved</b> )
RS-9	ASHRAE/IES Standard 90.1-1989, Efficient Design of Buildings Except New Low-Rise Residential Buildings.

- RS-10 through RS-17 (**Reserved**)  
 RS-18 SMACNA Duct Metal and Flexible Construction Standards, 1st Edition.  
 RS-19 through RS-24 (**Reserved**)  
 RS-25 Thermal Bridges in Sheet Metal Construction from Appendix E of RS-9.  
 RS-26 Super Good Cents Technical Reference.  
 RS-27 1993 ASHRAE Fundamentals Handbook.  
 RS-28 1992 ASHRAE HVAC Systems and Equipment Handbook.  
 RS-29 Commercial Building Design by Systems Analysis.  
 RS-30 Title 10, Code of Federal Regulations (CFR), Part 430 (March 14, 1988).  
 RS-31 National Fenestration Rating Council (NFRC) Standard 100-91.

#### ACCREDITED AUTHORITATIVE AGENCIES

**ANSI** refers to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018

**ARI** refers to the Air Conditioning and Refrigeration Institute, 4301 North Fairfax Drive, Suite 425, Arlington, VA 22203

**ASHRAE** refers to the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329

**ASTM** refers to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103

**CTI** refers to the Cooling Tower Institute, P.O. Box 73383 Houston TX 77273

**NFRC** refers to National Fenestration Rating Council, 1300 Spring Street, Suite 120, Silver Spring, MD 20910

**SMACNA** refers to the Sheet Metal and Air Conditioning Contractors National Association, Inc., 4201 Lafayette Center Drive, Chantilly, VA 22021-1209.

#### CHAPTER 18 (RESERVED)

#### CHAPTER 19 (RESERVED)

**CHAPTER 20**  
**DEFAULT HEAT-LOSS COEFFICIENTS**

NEW SECTION

**WAC 51-11-2000 Default heat-loss coefficients. (Reserved.)**

NEW SECTION

**WAC 51-11-2001 General.**

2001.1 Scope: The following defaults will apply to Chapters 11 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.

2001.2 Description: These coefficients were developed primarily from data and procedures from Standard RS-27, and taken specifically from Standard RS-26, listed in Chapter 17.

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 17, are used, along with data from the sources referenced above.

2001.3 Air Films: Default R-values used for air films shall be as follows:

R-Value	Condition
0.17	All exterior surfaces
0.61	Interior horizontal surfaces, heat flow up
0.72	Interior horizontal surfaces, heat flow down
0.68	Interior vertical surfaces

2001.4 Compression of Insulation: Insulation which is compressed shall be rated in accordance with Table 20-A or reduction in value may be calculated in accordance with the procedures in Standard RS-27 listed in Chapter 17.

TABLE 20-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	Actual Depth of Cavity	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

NEW SECTION

**WAC 51-11-2002 Below grade walls and slabs.**

2002.1 General: Table 20-1 lists heat-loss coefficients for below-grade walls and floors.

Coefficients for below-grade walls are given as U-factors (Btu/h•ft<sup>2</sup>•°F of wall area). Coefficients for below-grade slabs are listed as F-factors (Btu/h•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-factor, and vice versa.

2002.2 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 20-1, 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 shall be less 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.

2002.3 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 with 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 20-1**  
**Default Wall U-Factors and**  
**Slab F-Factors for Basements**

	<b>Below Grade Wall U-factor</b>	<b>Below Grade Slab F-factor</b>
<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
<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

NEW SECTION

**WAC 51-11-2003 On-grade slab floors.**

2003.1 General: Table 20-2 lists heat-loss coefficients for unheated and heated on-grade slab floors, in units of Btu/h•°F per lineal foot of perimeter.

2003.2 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/h•ft<sup>2</sup>•°F. Slabs two feet or more below grade should use basement coefficients.

2003.3 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.

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 two feet under the slab.

**TABLE 20-2  
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	--



## NEW SECTION

### **WAC 51-11-2004 Floors over unconditioned space.**

2004.1 General: Tables 20-3, 20-4 and 20-4a list heat loss coefficients for floors over unconditioned spaces in units of Btu/h $\cdot$ ft<sup>2</sup> $\cdot$ °F.

They are derived from procedures listed in Standard RS-27, listed in Chapter 17, assuming an average outdoor temperature of 45 degrees F, an average indoor temperature of 65 degrees F, and a crawl space area of 1350 ft<sup>2</sup> and one hundred feet of perimeter. The crawl space is assumed to be two and one-half feet high, with twenty-four inches below grade and six inches above grade.

2004.2 Category Description: Four configurations are considered: vented crawl space, unvented crawl space, heated plenum crawl space and exposed floor.

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

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

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

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

Exposed 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.

2004.3 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 crawl space 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 20-3**  
**Default U-Factors for Floors**  
**Over 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
38	0	0.024	0.025
	11	0.024	0.024

**TABLE 20-4**  
**Default U-factors for Floors Over**  
**Heated Plenum Crawlspace**

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

**Note:** Crawlspaces used as heated plenums have approximately 30-percent higher heat-loss rate than unvented crawlspaces with the same assumed ACH. Default U-factors in Table 20-4 reflect this higher rate of heat loss.

**TABLE 20-4a  
Exposed Floors**

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

NEW SECTION

**WAC 51-11-2005 Above grade walls.**

2005.1 General: Table 20-5, 20-5a and 20-5b list heat-loss coefficients for the opaque portion of above-grade wood stud frame walls, metal stud frame walls and concrete masonry walls (Btu/h•ft<sup>2</sup>•°F). They are derived from procedures listed in Standard RS-27, listed in Chapter 17.

2005.2 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.

Standard framing weighting factors:

Studs and plates	0.19
Insulated cavity	0.77
Headers	0.04

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.

Intermediate framing weighting factors:

Studs and plates	0.18
Insulated cavity	0.78
Headers	0.04

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.

Advanced Framing Weighting Factors:

Studs and plates	0.13
Insulated cavity	0.83
Headers	0.04

2005.3 Component Description: For wood stud frame walls, default coefficients for three types of walls are listed: Single-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.

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, nonstructural wall. Insulation is placed in both wall cavities and in the space between the two walls. Stud spacing is assumed to be on twenty-four inch centers for both walls.

**TABLE 20-5**  
**Default U-factors for Above-Grade Walls**

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

**NOTE:**

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

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

Siding Material/Framing Type				
R-value of foam Board	Lapped Wood		T1-11	
	STD	ADV	STD	ADV
0	.088	.084	.094	.090
1	.080	.077	.085	.082
2	.074	.071	.078	.075
3	.069	.066	.072	.070
4	.064	.062	.067	.065
5	.060	.058	.063	.061
6	.056	.055	.059	.057
7	.053	.052	.055	.054
8	.051	.049	.052	.051
9	.048	.047	.050	.049
10	.046	.045	.047	.046
11	.044	.043	.045	.044
12	.042	.041	.043	.042

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

**NOTE:**

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

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

Siding Material/Framing Type					
		Lapped Wood		T1-11	
R-value of foam Board	STD	ADV	STD	ADV	
0	.082	.078	.088	.083	
1	.075	.072	.080	.076	
2	.069	.066	.073	.070	
3	.065	.062	.068	.065	
4	.060	.058	.063	.061	
5	.057	.055	.059	.057	
6	.053	.052	.056	.054	
7	.051	.049	.052	.051	
8	.048	.047	.050	.048	
9	.046	.045	.047	.046	
10	.044	.043	.045	.044	
11	.042	.041	.043	.042	
12	.040	.039	.041	.040	

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

**NOTE:**

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

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

Siding Material/Framing Type					
		Lapped Wood		T1-11	
R-value of foam Board	STD	ADV	STD	ADV	
0	.076	.071	.081	.075	
1	.069	.065	.073	.069	
2	.064	.061	.068	.069	
3	.060	.057	.063	.059	
4	.056	.053	.059	.056	
5	.053	.051	.055	.052	
6	.050	.048	.052	.050	
7	.047	.046	.049	.047	
8	.045	.044	.047	.045	
9	.043	.042	.044	.043	
10	.041	.040	.042	.041	
11	.039	.038	.041	.039	
12	.038	.037	.039	.038	

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

**NOTE:**

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

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

Siding Material/Framing Type						
R-value of foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	.062	.058	.055	.065	.061	.058
1	.058	.055	.052	.060	.057	.055
2	.054	.052	.050	.056	.054	.051
3	.051	.049	.047	.053	.051	.049
4	.048	.046	.045	.050	.048	.046
5	.046	.044	.043	.048	.046	.044
6	.044	.042	.041	.045	.044	.042
7	.042	.040	.039	.043	.042	.040
8	.040	.039	.038	.041	.040	.039
9	.038	.037	.035	.039	.038	.037
10	.037	.036	.035	.038	.037	.036
11	.036	.035	.034	.036	.035	.035
12	.034	.033	.033	.035	.034	.033

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

**NOTE:**

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

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

Siding Material/Framing Type						
R-value of foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	.057	.054	.051	.060	.056	.053
1	.054	.051	.048	.056	.053	.050
2	.050	.048	.045	.052	.050	.047
3	.048	.045	.043	.049	.047	.045
4	.045	.043	.041	.047	.045	.043
5	.043	.041	.040	.044	.042	.041
6	.041	.039	.038	.042	.041	.039
7	.039	.038	.036	.040	.039	.037
8	.038	.036	.035	.039	.037	.036
9	.036	.035	.034	.037	.036	.035
10	.035	.034	.033	.036	.035	.033
11	.033	.033	.032	.034	.033	.032
12	.032	.031	.031	.033	.032	.031

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

**NOTE:**

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

Installed Batt R-value:  
R-22 in 5.5-inch cavity

Siding Material/Framing Type						
R-value of foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	.059	.055	.052	.062	.058	.054
1	.055	.052	.049	.057	.054	.051
2	.052	.049	.047	.054	.051	.048
3	.049	.046	.044	.050	.048	.046
4	.046	.044	.042	.048	.046	.044
5	.044	.042	.041	.045	.043	.042
6	.042	.040	.039	.043	.042	.040
7	.040	.039	.037	.041	.040	.038
8	.038	.037	.036	.039	.038	.037
9	.037	.036	.035	.038	.037	.035
10	.035	.034	.033	.036	.035	.034
11	.034	.033	.032	.035	.034	.033
12	.033	.032	.031	.034	.033	.032

**2 x 6 Single Wood Stud: R-11 Batt**

**NOTE:**

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

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

Siding Material/Framing Type						
R-value of foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	.060	.057	.054	.063	.059	.056
1	.056	.053	.051	.059	.056	.053
2	.053	.050	.048	.055	.052	.050
3	.050	.048	.046	.052	.049	.047
4	.047	.045	.044	.049	.047	.045
5	.045	.043	.042	.046	.045	.043
6	.043	.041	.040	.044	.043	.041
7	.041	.040	.038	.042	.041	.039
8	.039	.038	.037	.040	.039	.038
9	.038	.037	.036	.039	.038	.036
10	.036	.035	.034	.037	.036	.035
11	.035	.034	.033	.036	.035	.034
12	.034	.033	.032	.034	.034	.033

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

**NOTE:**

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

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

Siding Material/Framing Type						
R-value of foam Board	Lapped Wood			T1-11		
	STD	INT	ADV	STD	INT	ADV
0	.051	.047	.045	.053	.049	.046
1	.048	.045	.043	.049	.046	.044
2	.045	.043	.041	.047	.044	.042
3	.043	.041	.039	.044	.042	.040
4	.041	.039	.037	.042	.040	.038
5	.039	.037	.036	.040	.038	.037
6	.037	.036	.035	.038	.037	.036
7	.036	.035	.033	.037	.035	.034
8	.035	.033	.032	.035	.034	.033
9	.033	.032	.031	.034	.033	.032
10	.032	.031	.030	.033	.032	.031
11	.031	.030	.029	.032	.031	.030
12	.030	.029	.028	.031	.030	.029

**2 x 6: Strap Wall**

R-19 + R-11 Batts  
R-19 + R-8 Batts

Siding Material/Frame Type			
Lapped Wood		T1-11	
STD	ADV	STD	ADV
.036	.035	.038	.036
.041	.039	.042	.040

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

Batt Configuration		
Exterior	Middle	Interior
R-19	-----	R-11
R-19	-----	R-19
R-19	R-8	R-11
R-19	R-11	R-11
R-19	R-11	R-19
R-19	R-19	R-19

Siding Material/Frame Type			
Lapped Wood		T1-11	
STD	ADV	STD	ADV
.040	.037	.041	.038
.034	.031	.035	.032
.029	.028	.031	.029
.027	.026	.028	.027
.024	.023	.025	.023
.021	.020	.021	.020



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

**Batt Configuration**

Exterior	Middle	Interior
R-11	-----	R-11
R-19	-----	R-11
R-11	R-8	R-11
R-11	R-11	R-11
R-13	R-13	R-13
R-11	R-19	R-11

Sliding Material/Frame Type			
Lapped Wood		T1-11	
STD	ADV	STD	ADV
.050	.046	.052	.048
.039	.037	.043	.039
.037	.035	.036	.036
.032	.031	.033	.032
.029	.028	.029	.028
.026	.026	.027	.026

**Log Walls**

**NOTE:**

R-value of wood:  
R-1.25 per inch thickness.  
Average wall thickness  
90% average log diameter

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

**Stress Skin Panel**

**NOTE:**

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

Framing: 6%:

Spline: 8%

No thermal bridging between interior and exterior splines

Panel Thickness	U-factor
3 1/2-inch	.071
5 1/2-inch	.048
7 1/4-inch	.037
9 1/4-inch	.030
11 1/4-inch	.025

Metal Stud Walls: The nominal R-values in Table 20-5a 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 22 of RS-27.

**TABLE 20-5a**

Default U-Factors and Effective R-Values for Metal Stud Walls

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

Nominal Wall Thickness	Nominal Insulation R-Value	Overall Assembly U-Factors	
		16" O.C.	24" O.C.
4 inch	R-11	0.14	0.13
4 inch	R-13	0.13	0.12
4 inch	R-15	0.12	0.11
6 inch	R-19	0.11	0.10
6 inch	R-21	0.11	0.09
8 inch	R-25	0.10	0.09

**EFFECTIVE R-VALUES FOR METAL STUD AND INSULATED CAVITY ONLY**

Cavity		Insulation		
Nominal Depth	Actual Depth	Nominal R-Value	Effective R-value	
			16" O.C.	24" O.C.
4 inch	3-1/2 "	R-11	5.5	6.6
4 inch	3-1/2"	R-13	6.0	7.2
4 inch	3-1/2"	R-15	6.4	7.8
6 inch	5-1/2"	R-19	7.1	8.6
6 inch	5-1/2"	R-21	7.4	9.0
8 inch	7-1/4"	R-25	7.8	9.6

Concrete Masonry Walls: The nominal R-values in Table 20-5b 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 22 of RS-27.

**TABLE 20-5b**

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
Korfil Hi-R, Exposed Both Sides	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
Korfil Hi-R, Exposed Both Sides	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 20-5b

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 RS-27.

#### Heat Capacity

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

NEW SECTION

**WAC 51-11-2007 Ceilings.**

2007.1 General: Table 20-7 lists heat-loss coefficients for the opaque portion of exterior ceilings below vented attics, vaulted ceilings, and roof decks in units of Btu/h·ft<sup>2</sup>·°F of ceiling.

They are derived from procedures listed in RS-27, listed in Chapter 17. Ceiling U-factors are modified for the buffering effect of the attic, assuming an indoor temperature of 65 degrees F and an outdoor temperature of 45 degrees F.

2007.2 Component Description: The three 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 (h·ft<sup>2</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	0.036	0.031
5/12	0.035	0.030
6/12	0.034	0.029
7/12	0.034	0.029
8/12	0.034	0.028
9/12	0.034	0.028
10/12	0.033	0.028
11/12	0.033	0.027
12/12	0.033	0.027

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 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.

**TABLE 20-7**  
**Default U-factors for Ceilings**

<b>Ceilings Below Vented Attics</b>	<b>Standard Frame</b>	<b>Advanced Frame</b>
<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>U-factor</b>
R-15 Rigid Insulation	0.063
R-21 Rigid Insulation	0.045
R-25 Rigid Insulation	0.038
R-30 Rigid Insulation	0.032
R-38 Rigid Insulation	0.025
R-50 Rigid Insulation	0.019



NEW SECTION

**WAC 51-11-2008 (Reserved.)**

NEW SECTION

**WAC 51-11-2009 Mass.**

2009.1 General: Table 20-10 lists default mass-values. All calculations are based on standard ASHRAE values for heat-storage capacity as listed in RS-27, Chapter 22.

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:

$$\text{Ln(R-value)} \times (-0.221) + 0.5$$

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.

2009.2 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 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.

2009.3 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 20-10  
DEFAULT MASS VALUES**

<b>Structural Mass M-value floor area</b>	<b>Btu/ft<sup>2</sup> • °F</b>
<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

NEW SECTION

**WAC 51-11-1310 General requirements.** The building envelope shall comply with Sections 1311 through 1314.

1310.1 Conditioned Spaces: The building envelope for conditioned spaces shall also comply with one of the following paths:

- a. Prescriptive Building Envelope Option Sections 1320 through 1323.
- b. Component Performance Building Envelope Option Sections 1330 through 1334.
- c. Systems Analysis. See Section 1141.4.

1310.2 Semi-Heated Spaces: All spaces shall be considered conditioned spaces, and shall comply with the requirements in Section 1310.1 unless they meet the following criteria for semi-heated spaces. The installed heating equipment output, in Climate Zone 1, shall be 3 Btu/(h•ft<sup>2</sup>) or greater but not greater than 8 Btu/(h•ft<sup>2</sup>) and in Climate Zone 2, shall be 5 Btu/(h•ft<sup>2</sup>) or greater but not greater than 12 Btu/(h•ft<sup>2</sup>). Heating shall be controlled by a thermostat mounted not lower than the heating unit and capable of preventing heating above 44 degrees space temperature. For semi-heated spaces, the only prescriptive, component performance, or systems analysis building envelope requirement shall be that:

Climate Zone 1

- a. U=0.10 maximum for the roof assembly, or
- b. continuous R-9 insulation installed entirely outside of the roof structure, or
- c. R-11 insulation installed inside or within a wood roof structure, or
- d. R-19 insulation installed inside or within a metal roof structure.

Climate Zone 2

- a. U=0.07 maximum for the roof assembly, or
- b. continuous R-14 insulation installed entirely outside of the roof structure, or
- c. R-19 insulation installed inside or within a wood roof structure, or
- d. R-25 insulation installed inside or within a metal roof structure.

**Figure 13A  
Building Envelope Compliance Options**

<b>Section Number</b>	<b>Subject</b>	<b>Prescriptive Option</b>	<b>Component Performance Option</b>	<b>Systems Analysis Option</b>
1310	General Requirements	X	X	X
1311	Insulation	X	X	X
1312	Glazing and Doors	X	X	X
1313	Moisture Control	X	X	X
1314	Air Leakage	X	X	X
1320	Prescriptive Building Envelope Option	X		
1321	General	X		
1322	Opaque Envelope	X		
1323	Glazing	X		
1330	Component Performance Building Envelope Option		X	
1331	General		X	
1332	Component U-Factors		X	
1333	UA Calculations		X	
1334	Solar Heat Gain Coefficient		X	
RS-29	Systems Analysis			X

NEW SECTION

**WAC 51-11-1311 Insulation.**

1311.1 Installation Requirements: All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, maintain clearances, and maintain uniform R-values. To the maximum extent possible, insulation shall extend over the full component area to the intended R-value.

1311.2 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 three feet in twelve and there is at least thirty 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.

Where lighting fixtures are recessed into a suspended or exposed grid ceiling, the roof/ceiling assembly shall be insulated in a location other than directly on the suspended ceiling.

Exception: Type IC rated recessed lighting fixtures.

Where installed in wood framing, faced batt insulation shall be face stapled.

1311.3 Wall Insulation: Exterior wall cavities isolated during framing shall be fully insulated to the levels of the surrounding walls. When installed in wood framing, faced batt insulation shall be face stapled.

Above grade exterior insulation shall be protected.

1311.4 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 not more than twenty-four inches on center. Installed insulation shall not block the airflow through foundation vents.

1311.5 Slab-On-Grade Floor: Slab-on-grade insulation installed inside the foundation wall shall extend downward from the top of the slab a minimum distance of twenty-four inches or to the top of the footing, whichever is less. Insulation installed outside the foundation shall extend downward a minimum of twenty-four inches or to the frostline, whichever is greater. Above grade insulation shall be protected.

Exception: For monolithic slabs, the insulation shall extend downward from the top of the slab to the bottom of the footing.

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

If required by the building official where soil conditions warrant such insulation, the entire area of a radiant floor shall be thermally isolated from the soil. Where a soil gas control system is provided below the radiant floor, which results in increased convective flow below the radiant floor, the radiant floor shall be thermally isolated from the sub-floor gravel layer.

#### NEW SECTION

**WAC 51-11-1334 Solar heat gain coefficient.** Solar heat gain coefficient shall comply with Section 1323.3.

## EQUATION 13-1:

### Target $UA_t$

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

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

Where:

$U_{rat}$  = The thermal transmittance value for roofs over attics found in Table 13-1 or 13-2.

$U_{ograt}$  = 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.

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

$U_{ogort}$  = 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.

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

$U_{vgt}$  = 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.

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

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

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

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

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

$A_{ft}$  = The proposed floor over unconditioned space area,  $A_f$ .

$P_{st}$  = The proposed lineal feet of slab-on-grade and radiant slab floor perimeter,  $P_s$ .

$A_{bgwt}$  = The proposed below grade wall area,  $A_{bgw}$ .  
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:

$A_{rat}$  = The proposed roof over attic area,  $A_{ra}$ .

$A_{ograt}$  = The proposed overhead glazing area in roofs over attics,  $A_{ogra}$ .

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

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

$A_{wt}$  = 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.

$U_d$  = Thermal transmittance value of 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:

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



**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

**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>	Maximum U-Factor		Max. SHGC <sup>4</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	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:** Below grade walls shall be insulated either on the interior or the exterior. Below grade walls insulated on the exterior shall use a minimum of R-10 insulation. Below grade walls insulated on the interior shall use opaque wall values. No insulation is required for those portions of below grade walls and footings that are more than ten feet below grade. Below grade walls, however, shall not be included in the gross exterior wall area unless insulated to the levels given above.
- Concrete Masonry Walls:** If the area weighted heat capacity of the total opaque above grade wall is a minimum of 9.0 Btu/ft<sup>2</sup> • °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. Individual walls with heat capacities less than 9.0 Btu/ft<sup>2</sup> • °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 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	NOT ALLOWED		
2. All others including Heat pumps and VAV	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.
- SHGC (Solar Heat Gain Coefficient per Section 1312.2):** May substitute Maximum Shading Coefficient (SC) for SHGC. (See Section 1210 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 <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-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

**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>4</sup>	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		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:** Below grade walls shall be insulated either on the interior or the exterior. Below grade walls insulated on the exterior shall use a minimum of R-12 insulation. Below grade walls insulated on the interior shall use opaque wall values. No insulation is required for those portions of below grade walls and footings that are more than ten feet below grade. Below grade walls, however, shall not be included in the gross exterior wall area unless insulated to the levels given above.
- Concrete Masonry Walls:** If the area weighted heat capacity of the total opaque above grade wall is a minimum of 9.0 Btu/ft<sup>2</sup> • °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. Individual walls with heat capacities less than 9.0 Btu/ft<sup>2</sup> • °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 %			
	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
2. All others including Heat pumps and VAV	0.75	1.40	0.85	0.60	1.30	0.70	0.50	1.25	0.45

- Metal Stud Walls:** For metal stud construction U=0.10.
- SHGC (Solar Heat Gain Coefficient per Section 1312.2):** May substitute Maximum Shading Coefficient (SC) for SHGC. (See Section 1210 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.

NEW SECTION

**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. Stair shaft and elevator shaft smoke relief openings shall be equipped with normally open dampers. These dampers shall remain closed in normal operation until activated by the fire alarm system or other approved smoke detection system.

Exceptions:

1. Systems serving areas which require continuous operation.
2. Combustion air intakes.

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.

#### NEW SECTION

##### **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 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.

1414.2 Insulation: Ducts and plenums that are constructed as part of the building envelope shall meet the requirements of Chapter 13. 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 that serves that space only.

#### NEW SECTION

**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	(N/A) (N/A)	10.0 SEER 9.7 SEER	ARI 210/240 -1989
	>65,000 and ≤135,000 Btu/h Cooling Capacity	All Unitary	8.9 EER	8.3 IPLV	
	>135,000 and ≤760,000 Btu/h <sup>1</sup> Cooling Capacity	Standard Ratings:	95°F db	80°F db	ARI 360 -1986
	>760,000 Btu/h <sup>1</sup> Cooling Capacity	Air Conditioners Heat Pumps	8.5 EER 8.5 EER	7.5 IPLV 7.5 IPLV	
Packaged Term. Air Conditioners & Heat Pumps Cooling Ratings	All Capacities	Air Conditioners and Heat Pumps  Standard/Low Temp	10.0 - (0.16 x Cap/1000) <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	3.0 COP	2.0 COP	
	>135,000 Btu/h Cooling Capacity	Standard Ratings	47°F db/43°F wb 2.9 COP 47 °F	17°F db/15°F wb 2.0 COP 17 °F	ARI 365 -1986
Packaged Term. Heat Pumps Heating Ratings	All Capacities	Heat Pumps  Standard Ratings	2.9 - (0.026x Cap/1000) <sup>3</sup> EER 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 10CFR 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>	(N/A) (N/A)	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>	(N/A) (N/A)	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>	(N/A)	ANSI Z83.9
		Min Rated Capacity <sup>6</sup>	75% E <sub>t</sub> <sup>4</sup>	(N/A)	-1986
	All Size Gas Unit Heaters	Max Rated Capacity <sup>6</sup>	78% E <sub>t</sub> <sup>4</sup>	(N/A)	ANSI Z83.8
		Min Rated Capacity <sup>6</sup>	74% E <sub>t</sub> <sup>4</sup>	(N/A)	-1985
All Size Oil Unit Heaters	Max Rated Capacity <sup>6</sup>	81% E <sub>t</sub> <sup>4</sup>	(N/A)	UL 731	
	Min Rated Capacity <sup>6</sup>	81% E <sub>t</sub> <sup>4</sup>	(N/A)	-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 (E<sub>t</sub>), (100% flue losses).
- To be consistent with National Appliance Energy Conservation Act (NAECA) of 1987 (Public Law 100-12). These values apply to furnace and combination units covered by NAECA.
- Minimum and maximum ratings as provided for and allowed by the unit's controls.

**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 ARI 590-86pN CTI 201 -1986
	≥ 150 and < 300 Tons		4.2 COP	4.5 IPLV	
	≥ 300 Tons		5.2 COP <sup>4</sup>	5.3 IPLV <sup>4</sup>	
	< 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>	(N/A) (N/A)	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>
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 <sub>c</sub> <sup>4</sup> 80%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	E <sub>c</sub> <sup>4</sup> 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 <sub>c</sub> <sup>4</sup> 83%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	E <sub>c</sub> <sup>4</sup> 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 <sub>c</sub> <sup>4</sup> 83%
		2. Min. Rated Capacity <sup>2</sup> Steady-State	E <sub>c</sub> <sup>4</sup> 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<sub>c</sub> = 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 Location	Insulation R-Value
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 <sup>1</sup>
Not within conditioned space: in concrete, in ground	R-5.3
Supply air ducts within conditioned space with HVAC equipment supply air temperature <55 or >105 <sup>o</sup> F	R-3.3

**Note:** Requirements apply to both supply and return ducts, 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.

1. With approved weatherproof barrier.

**INSULATION TYPES:** Minimum densities and out of package thickness. Nominal R-values are for the insulation as installed and do not include air film resistance.

**INSTALLED:**

- R-3.3** 1.0 inch 1.5 to 3 lb/cu.ft. duct liner, mineral or glass fiber blanket or equivalent to provide an installed total thermal resistance of at least R-3.3.
- R-5.3** 2.0 inch 0.75 lb/cu.ft. mineral or glass fiber blanket, 1.5 inch 1.5 to 3 lb/cu.ft. duct liner, mineral or glass fiber blanket, 1.5 inch 3 to 7 lb/cu.ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-5.3.
- R-7** 3-inch 0.75 lb/cu./ft. mineral or glass fiber blanket, 2-inch 1.5 to 3 lb/cu.ft. duct liner, mineral or glass fiber blanket, 2-inch 3 to 7 lb/cu.ft. mineral or glass fiber board or equivalent to provide an installed total thermal resistance of at least R-7.



**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:

$$T = PR[1 + t/PR]^{K/k} - 1]$$

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.

NEW SECTION

**WAC 51-11-1513 Lighting controls.**

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, 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.

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 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.

#### NEW SECTION

**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 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.

Exception: Group M occupancy accessory to Group R occupancy.

**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	1.5
Wholesale stores (pallet rack shelving)	1.5
Mall concourses	1.4
Schools buildings, 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, gymnasias <sup>9</sup> , theaters	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
<b>Plans Submitted for Common Areas Only<sup>7</sup></b>	
Common area, corridors, lobbies (except mall concourse)	0.8
Toilet facilities and washrooms	0.8

### Footnotes for Table 15-1

1. 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 for free-standing display, 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.

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.

NEW SECTION

**WAC 51-11-2006 Default U-factors for glazing and doors.**

2006.1 Untested Glazing and Doors: Untested glazing and doors shall be assigned the following U-factors:

**TABLE 20-6**

Default U-Factors for Vertical Glazing, Overhead Glazing and Opaque Doors

**Vertical Glazing**

	U-Factor
Single	1.45
Double	0.90
1/2 Inch Air, Fixed	0.75
1/2 Inch Air, Low-e <sup>(0.40)</sup> , Fixed	0.60
1/2 Inch Argon, Low-e <sup>(0.10)</sup> , Fixed	0.50

**Overhead Glazing**

	U-Factor	
	Any Frame	Vinyl/Wood Frame
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

**Opaque Doors**

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

**NOTES:**

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

**REFERENCE STANDARD COMMERCIAL  
BUILDING DESIGN BY SYSTEMS ANALYSIS**

NEW SECTION

**WAC 51-11-99901 Section 1--Scope.**

**1.1 General:** This Standard establishes design criteria in terms of total energy consumption of a building, including all of its systems. General principles and requirements are outlined in Section 2. Specific modeling assumptions are listed in Section 3.

The building permit application for projects utilizing this Standard shall include in one submittal all building and mechanical drawings and all information necessary to verify that the design for the project corresponds with the annual energy analysis. If credit is proposed to be taken for lighting energy savings, then electrical drawings shall also be included with the building permit application.

Due to the various assumptions that are necessary, the results of the analysis shall not be construed as a guarantee of the actual energy performance of the project.

NEW SECTION

**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, 1440 through 1442, 1450 through 1454 and 1510 through 1513. Buildings shall only vary from those requirements in Sections 1330 through 1334, 1432 through 1438 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 17 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 12 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.

## NEW SECTION

### **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, 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, 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:** The energy 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, 1987 HVAC Systems and Applications Volume and meeting all the requirements of Sections 1440 through 1442.

### 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 war uses 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>**

<b>Building Type</b>	<b>Occupancy Density<sup>2</sup> Sq. Ft./Person (Btu/h·sq. ft)</b>	<b>Receptacle Power Density<sup>3</sup> Watts/Sq. Ft. (Btu/h·sq. ft.)</b>	<b>Service Hot Water Quantities<sup>4</sup> Btu/h·person</b>
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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun
1 (12-1am)	0	0	0	5	5	5	off	off	off	0	0	0	0	0	0
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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. THESE VALUES MAY BE 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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)									Based						
12 (11-12pm)				N/A					on			N/A			
13 (12-1pm)									likely						
14 (1-2pm)									use						
15 (2-3pm)															
16 (3-4pm)															
17 (4-5pm)															
18 (5-6pm)															
19 (6-7pm)															
20 (7-8pm)															
21 (8-9pm)															
22 (9-10pm)															
23 (10-11pm)															
24 (11-12am)															
Total/Day					2400	2400	2400								
Total/Week															
Total/Year															

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
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		

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

**TABLE 3-2i**  
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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
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

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. 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		
	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	Sat	Sun	Wkdy	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
Total/Year		1835	hours		2542	hours		3024	hours		1193	hours		182	hours

1. Schedules for occupancy, lighting, receptacle, HVAC system and service hot water are from ASHRAE Standard 90.1-1989 and addendums, except that 5 percent 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 percent when occupancy is 0 percent. THESE VALUES MAY BE USED ONLY IF ACTUAL SCHEDULES ARE NOT KNOWN.

**TABLE 3-3**  
**HVAC Systems of Prototype Buildi.**

Use	System #	Remarks
1. Assembly a. Churches (any size) b. $\leq 50,000 \text{ ft}^2$ or $\leq 3$ floors c. $> 50,000 \text{ ft}^2$ or $> 3$ floors	1 1 or 3 3	Note 2
2. Health a. Nursing Home (any size) b. $\leq 15,000 \text{ ft}^2$ c. $> 15,000 \text{ ft}^2$ and $\leq 50,000 \text{ ft}^2$ d. $> 50,000 \text{ ft}^2$	2 1 4 5	Note 3 Note 3,4
3. Hotel/Motel a. $\leq 3$ Stories b. $> 3$ Stories	2 6	Note 6 Note 7
4. Light Manufacturing	1 or 3	
5. Office a. $\leq 20,000 \text{ ft}^2$ b. $> 20,000 \text{ ft}^2$ and either $\leq 3$ floors or $\leq 75,000 \text{ ft}^2$ c. $> 75,000 \text{ ft}^2$ or $> 3$ floors	1 4 5	
6. Restaurant	1 or 3	Note 2
7. Retail a. $\leq 50,000 \text{ ft}^2$ b. $> 50,000 \text{ ft}^2$	1 or 3 4 or 5	Note 2 Note 2
8. Schools a. $\leq 75,000 \text{ ft}^2$ or $\leq 3$ floors b. $> 75,000 \text{ ft}^2$ or $> 3$ floors	1 3	
9. Warehouse		Note 5

Footnote to TABLE 3-3: The systems and energy types presented in this table are not intended as requirements or recommendations for the proposed design. Floor 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.
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 System 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.
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.	N.A.
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.
4. Provide run-around heat recovery systems for all fan systems with a minimum outside air intake greater than 70 percent. 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 percent 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 percent combined impeller and motor efficiency. Condenser water pumps shall be sized using a 10° 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° 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 percent. Hot water supply temperature shall be reset in accordance with Section 1432.2.2.

NEW SECTION

**WAC 51-11-99904 Section 4--Suggested software for systems analysis approach.**

**4.1 Programs Acceptable for Projects for Full-Year Hourly Analysis**

<b>Program Name</b>	<b>Source</b>
ADM-DOE	ADM Associates 3299 Ramos Circle Sacramento, CA 95827 916-363-8383
Micro-Access 10.1, PC	Edison Electric Institute PO Box 1235 Roswell, GA 30077 404-993-2406
Blast 3.0 (Level 193)	Blast Support Office University of Illinois Dept. of Mechanical and Industrial Engineering 1206 W. Green Room 30, MEB Urbana, Il 61801 1-800-842-5278
DOE 2.1	Energy Science and Technology Software Center PO Box 1220 Oakridge, TN 37831-1020 615-576-2606
ESAS	Ross Meriweather Consulting, Engineering 3315 Outrider San Antonio, TX 78247-4405 512-490-7081
ESP-II	Automated Procedures for Engineering Consultants, Inc. Miami Valley Tower, Suite 2100 40 W. 4th St Dayton, OH 45402 513-228-2602
HAP 2.02	Carrier Air Conditioning 655 S. Orcas, Suite 10 Seattle, WA 98108 206-767-6340
MICRO-DOE	Acrosoft International, Inc. 9745 E. Hampden Ave, Suite 230 Denver, CO 80231 303-368-9225
ULTRA 600 Version 11.9	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 3299 Ramos Circle Sacramento, CA 95827 916-363-8383

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Advanced Science  
2000 N. 15th St., Suite 407  
Arlington, VA 22201-2627  
703-243-4900

Building Energy  
Analysis and Easy DOE

Elite Software  
PO Drawer 1194  
Bryan, TX 77806  
409-846-2340

ESE

Sea Gate  
5001 W. 80th St., Suite 204  
Bloomington, MN 55437  
612-844-8000

Trakload 4.0  
Load Shaper  
Market Manager

SRC Systems  
1300 Clay St., Suite 850  
Oakland, CA 94612  
510-839-2700

XENCAP 4.5

XENERGY  
492 9th Street, Suite 220  
Oakland, CA 94607  
510-891-0446