CHAPTER 13
ENERGY CONSERVATION

PART I

DIVISION I — SCOPE AND DEFINITIONS

SECTION 1301
SCOPE

The provisions of this chapter regulate the exterior envelope; the design, construction and selection of heating, ventilating and air-conditioning systems, piping insulation, service water heating systems and lighting required for the purpose of effective conservation of energy within a building or structure governed by this code.

For detached, Group R, Division 3 occupancies, three stories or less in height, see the *Oregon Residential Specialty Code*.

1301.1 Application to existing buildings. Alteration and repairs, historic buildings and change of use or occupancy to buildings, structures or portions thereof shall comply with the requirements in Sections 1301.1.1 through 1301.1.3.

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

1301.1.1 Alteration and repair. Alterations and repairs affecting energy conservation measures shall conform to the requirements specified in this chapter.

Alterations or repairs that affect components of existing conditioned spaces regulated in this chapter shall comply with this chapter.

Exception: Residential buildings may use the minimum component requirements as specified in Note 4 of Table 13-B to the maximum extent practical.

1301.1.2 Historic buildings. The building official may modify the specific requirements of this chapter for historic buildings and require in lieu thereof alternative requirements that will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings specifically designated as historically significant by the state historic preservation office(r) or by official action of a local government (see Section 3403.5).

1301.1.3 Change of occupancy or use.

1301.1.3.1 Changing use or occupancy to Group R, three stories and less in height. A building or portion of a building that is changing occupancy or use to a residential building, as defined by this chapter, must use the minimum component requirements as specified in Note 4 of Table 13-B to the greatest extent practical.

Exception: The minimum component requirements may be disregarded when thermal performance calculations (Table 13-B) are completed for change of use to a residential building.

1301.1.3.2 Changing use or occupancy for other buildings. A building that changes occupancy or use, without any changes to the components regulated in this chapter, is not required to comply with this chapter.

1301.2 Additions. Additions to existing buildings or structures may be made without making the entire building or structure comply, if the new additions comply with the requirements of this chapter.

1301.3 Information on plans and specifications. 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: exterior envelope component materials; *U*-factors of the respective elements, including insulation; *R*-values of insulating materials; size and type of apparatus and equipment; equipment and system controls; lighting space types when using Section 1313.4; and other pertinent data to indicate conformance with the requirements of this chapter.

SECTION 1302
DEFINITIONS

AFUE (Annual Fuel Utilization Efficiency). The energy output divided by the energy input, calculated on an annual basis and including part load and cycling effects. AFUE ratings shall be determined using the U.S. Department of Energy test procedures (10 CFR Part 430) and listings in the Gas Appliance Manufacturers Association (GAMA) *Consumer Directory of Certified Furnace and Boiler Efficiency Ratings*.

ASHRAE. The American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc.

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

BELOW-GRADE WALLS The walls or the portion of walls entirely below the finished grade or which extend 2 feet (610 mm) or less above the finish grade.

BTU (BRITISH THERMAL UNIT) The amount of heat required to raise the temperature of 1 pound (0.454 kg) of water (about 1 pint) from 59ºF to 60ºF (15ºC to 16ºC).

BUILDING ENVELOPE That element of a building which encloses conditioned spaces through which thermal energy may be transmitted to or from the exterior or to or from unconditioned or semiconditioned spaces.

C (THERMAL CONDUCTANCE). See "Thermal conductance."

CLIMATE ZONE. One of two geographic areas of the state with similar winter climate conditions. A building site is in Climate Zone 1 if its elevation is less than 3,000 feet (915 m) above sea level and is within one of the following counties: Benton, Columbia, Clackamas, Clatsop, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Yamhill or Washington. Building sites not in Zone 1 are in Zone 2.

COEFFICIENT OF PERFORMANCE (COP) - COOLING.

1. The COP for electrically operated (HVAC) equipment is the ratio of the rate of net heat removal to the rate of total energy input expressed in consistent units and under designated rating conditions.
2. The COP for heat-operated HVAC system equipment is the ratio of the net cooling output to the total heat input. The rate of net heat removal as used within this definition shall be the difference in total heat contents of the water or refrigerant entering and leaving the component. The total energy input as used within this system shall be determined by combining the energy inputs to all elements and accessories of the component, including, but not limited to, compressors, internal circulating pumps, condenser-air fans, evaporative-condenser cooling water pumps, purge and the HVAC system components control circuit.

COEFFICIENT OF PERFORMANCE (COP) – HEAT PUMP, HEATING. The ratio of the rate of net heat output to the rate of total energy input expressed in consistent units and under designated rating conditions. Supplementary heat shall not be included when checking compliance with required heat pump COPs.

CONDITIONED SPACE. A space within a building envelope is heated or cooled by an HVAC system (also see Semiconditioned Space).

CONDITIONED SPACE – RESIDENTIAL BUILDINGS. is a space within the building which is at least 5 feet (1.5 m) in height from finished floor to finished ceiling and which, by introduction of conditioned air, by heated and/or cooled surfaces, or by air or heat transfer from directly conditioned spaces is maintained at temperatures of 55ºF (13ºC) or higher for heating and/or 85ºF (29.4ºC) or below for cooling. (Enclosed corridors between conditioned spaces shall be considered as conditioned space. Spaces where temperatures fall between this range by virtue of ambient conditions shall not be considered as conditioned space.)

CONNECTED LIGHTING POWER. The total connected lighting power is calculated by summing the wattage of all luminaires.

COOLED SPACE. A space within a building provided with a mechanical cooling supply.

DEMISING ELEMENT. A building element consisting of walls, windows, doors, floors or ceilings that separates conditioned space from either unconditioned or semiconditioned space(s).

ECONOMIZER, AIR. Equipment capable of automatically modulating to use up to 85 percent of the fan system capacity for cooling with outdoor air as the first stage of cooling.

ECONOMIZER, WATER. A system by which the supply air of a cooling system is cooled directly or indirectly or both by evaporation of water or another appropriate fluid to reduce or eliminate the need for mechanical refrigeration.

EER (ENERGY EFFICIENCY RATIO) EER is calculated by dividing the cooling capacity in Btu per hour (Btu/hr) by the power input in watts at any given set of rating conditions, expressed in Btu/hr per watt.

EXTERIOR BUILDING LIGHTING. Lighting directed to illuminate the exterior of the building and adjacent walkways and loading areas with or without canopies.

EXTERIOR DOOR. A permanently installed operable barrier by which an entry is closed and opened. Exterior doors include doors between conditioned and unconditioned spaces, such as a door between a kitchen and garage.

EXTERIOR ENVELOPE. See "Building envelope."

EXTERIOR WALL. Any member or group of members that defines the exterior boundaries of the conditioned space and that has a slope of 60 degrees or greater with the horizontal plane.

EXTERIOR WINDOW. An opening, especially in the wall of a building, for admission of light or air that is usually closed by casement or sashes containing transparent material (such as glass) and may be openable. An exterior window includes all areas, including frames, in the exterior envelope of a conditioned space that lets in natural light, including skylights, sliding glass doors, glass block walls and the glazed portions of the doors.

When calculating the energy performance of the exterior envelope, the area of the window shall be the total area of glazing measured using the rough opening dimensions, and including the glass, sash and frame.

FENESTRATION. Windows and doors in the exterior envelope (see "Exterior door" and "Exterior window").

FLOOR AREA. The area included within the surrounding exterior walls of a building or portion thereof, exclusive of vent shafts and courts. The floor area of a building or portion thereof, not provided with surrounding exterior walls, shall be the usable area under the horizontal projection of the roof or floor above.

GLAZING. All areas, including frames in the shell of a conditioned space, that let in natural light, including windows, clerestories, skylights, sliding glass doors, glass block walls and the glazed portion of doors.

GROSS AREA OF EXTERIOR WALLS. Consists of wall areas, as measured on the exterior, including foundation walls above grade; peripheral edges of floors; window areas, including sash; and door areas, where such surfaces are exposed to outdoor air or semiconditioned spaces and enclose a heated or mechanically cooled space.

HEATED SLAB-ON-GRADE. A concrete slab-on-grade with embedded electric heating coils or embedded piping designed to carry a heated circulating fluid.

HEATED SPACE. A space within a building that is provided with a positive heat supply to maintain an air temperature of 55ºF (13ºC) or higher.

HEATED SPACE — OTHER BUILDINGS. A space within a building served by a mechanical, electrical or combustion source of heat. Spaces within a basement shall be defined as heated when any of the following apply: the space is finished, has heating registers or contains heating devices.

HSPF (HEATING SEASONAL PERFORMANCE FACTOR). The total heating output of a heat pump during its normal annual usage period for heating divided by the total electric power input in watt-hours during the same period.

HUMIDISTAT. An instrument that measures changes in humidity and controls a device or devices to maintain a desired humidity.

HVAC (HEATING, VENTILATING AND AIR-CONDITIONING) SYSTEM. The equipment, distribution network and terminals that provide either collectively or individually the heating, ventilating, and/or air-conditioning processes to a building.

IPLV (INTEGRATED PART LOAD VALUE). A single number figure 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.

K (Thermal Conductivity). See "Thermal conductivity."

LIGHTING POWER BUDGET. The upper limit of power to be available to provide the lighting needs for a building, including all permanently connected lighting.

LIGHTING POWER DENSITY. The maximum allowable lighting density as expressed in watts per square foot for a particular occupancy/space type.

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 their power supply. Many luminaires include one or more ballasts.

MANUAL (nonautomatic). An action that requires human intervention as the basis for control (see "Automatic").

OPAQUE ENVELOPE AREA. All exposed areas of a building envelope that enclose a conditioned space, except openings for doors and glazing.

OTHER BUILDINGS. All buildings and structures, or portions thereof, that are not defined as residential buildings (see "Residential buildings").

PACKAGED TERMINAL AIR CONDITIONER. A factory-selected combination of heating and cooling components, assemblies or sections, intended to serve a room or zone.

PERM RATING (Dry Cup). The measure of the ability of a material of specific thickness to transmit moisture in terms of the amount of moisture transmitted per unit time for a specified area and differential pressure. Dry cup perm rating is expressed in grains/(hr-ft^2-in-Hg). Permeance may be measured by using ASTM E 96-72 or other approved dry cup method. The closer the dry cup perm rating approaches zero, the better the vapor barrier. Permeability is defined as the permeance of a material for specified unit length (perm/in).

R (Thermal Resistance). See "Thermal resistance."

REHEAT. The heating of 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.

RESIDENTIAL BUILDINGS. Buildings and structures, or portions thereof, of the following occupancy classifications, within the specified limitations:

1. All Group R occupancies three stories or less in height;

2. Group SR-1, SR-3, SR-4 and I-1 occupancies three stories or less in height. Group SR-2 occupancy shall comply with "Other buildings" requirements.

SC (SHADING COEFFICIENT). The ratio of solar heat gain through fenestration with or without integral shading devices to that occurring through unshaded $^1/_8$-inch (3.2 mm) clear double strength glass.

SEER (SEASONAL ENERGY EFFICIENCY RATIO). The total cooling of a central unitary air-conditioner or unitary heat pump in Btu during its normal annual usage period for cooling divided by the total electrical energy input in watt-hours during the same period.

SEMICONDITIONED SPACES. Spaces that have a limited heating system output capacity that does not exceed the values listed below, and where each heating system is controlled by a thermostat with a maximum setpoint capacity of 45°F (7°C), mounted no lower than the heating unit for convection systems or below the heating unit for radiation systems.

Climate Zone 1: 15 Btu/hr.ft.^{2} (47 W/m^2) or 4 Watts/ ft.^{2} (47 W/m^2) of heated floor area.

Climate Zone 2: 20 Btu/hr.ft.^{2} (63 W/m^2) or 6 W/ft.^{2} (63 W/m^2) of heated floor area.

SERVICE WATER HEATING. The supply of hot water for purposes other than comfort heating and process requirements.

SIGN. A lettered display used to identify or advertise a place of business or products.

TERMINAL ELEMENT. The means by which the transformed energy from a system is finally delivered, such as registers, diffusers, lighting fixtures and faucets.

THERMAL CONDUCTANCE (C). The constant time rate of heat flow through a unit area of a body induced by a unit temperature difference between the surfaces, Btu/(hr-ft^2-ºF). It is the reciprocal of thermal resistance (see "Thermal Resistance").

THERMAL CONDUCTIVITY (K). The rate of heat flow through 1 square foot (0.929 m^2) of a homogeneous material 1 inch (25 m) thick when there is a temperature difference of 1ºF between the opposite faces of the material, expressed as Btu/hr per square foot per ºF temperature difference. Thermal conductivity is similar to thermal conductance (C), except thermal conductance applies to the actual thickness of the material.

THERMAL RESISTANCE (R). The measure of the resistance of a material or building component to the passage of

heat, has the value of (hr-ft^2-ºF)/Btu and is the reciprocal of thermal conductance.

THERMAL TRANSMITTANCE (U). The coefficient of heat transfer. It is the time rate of heat flow per unit area under steady state conditions from the fluid on the warm side of the barrier to the fluid on the cold side, per unit temperature difference between the two fluids, Btu/(hr-ft^2-ºF).

THERMOSTAT. An instrument that measures changes in temperature and controls a device or devices to maintain a desired temperature.

U (THERMAL TRANSMITTANCE). See "Thermal transmittance." To demonstrate compliance with this chapter, three decimal places are the significant value.

VAPOR BARRIER. A film, duplex paper, aluminum foil or other material that restricts the movement of water vapor from an area of high vapor pressure to one of lower vapor pressure.

VAULTED CEILING. In a residential building, a ceiling with a minimum pitch of 2 in 12.

WINDOW. See "Exterior window."

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

SECTION 1303
SOLAR ENERGY COLLECTORS

1303.1 General. Collectors that function as building components shall comply with the applicable provisions of the code.

Collectors located above or upon a roof and not functioning as building components shall not reduce the required fire-resistance or fire-retardancy classification of the roof-covering materials.

Exceptions:

1. Collectors installed on one- and two-family dwellings.
2. Noncombustible collectors located on buildings not over three stories in height or 9,000 square feet (836 m^2) in total floor area.
3. Collectors that comply with the provisions of Section 2603.14.

DIVISION II—RESIDENTIAL BUILDINGS

Sections 1304 through 1310 and 1320 through 1324 are applicable to residential buildings. See Section 1302, Definitions, for applicable residential building types.

SECTION 1304
METERING OF MULTIFAMILY RESIDENTIAL BUILDINGS

Each dwelling unit of multifamily residential buildings shall be individually metered as required by ORS 455.420. For purposes of this section, a "multifamily residential building" is an "apartment house" as defined in this code.

Exception: The building official may approve the installation of a central (master) electric meter on a multifamily residential building if documents prepared by a supervising journeyman electrician or an engineer licensed in this state are provided, showing that use of a master electric meter will consume less electrical energy than the building would use if separate electric meters were installed for each individual dwelling unit.

ORS 455.420 is not a part of this code but is reproduced here for the reader's convenience:

455.420 Individual electric meters required in multi-residential buildings; exceptions: standards.

(1) Each individual dwelling unit in a multifamily residential building constructed after October 4, 1977, shall have installed a separate, individual electrical meter for each dwelling unit, except where a building inspector certified under ORS 455.715 to 455.740 determines that, pursuant to standards adopted by the director of the Department of Consumer and Business Services, the installation of a single, central electrical meter for all the dwelling units in such a building would facilitate an overall reduction in electrical consumption by such units.

(2) For the purpose of carrying out the provisions of subsection (1) of this section, the director, based on recommendations of the Residential Structures Board, shall adopt by rule standards for determining whether the installation of a single electrical meter for all dwelling units in a multifamily residential building facilitates an overall reduction in electrical consumption by such units.

SECTION 1305
RESERVED

SECTION 1306
ALTERNATIVE METHOD OF COMPLIANCE USING THE WHOLE BUILDING APPROACH – RESIDENTIAL

1306.1 General. Alternative building systems and equipment design may be approved by the building official for residential buildings. Applicants shall demonstrate that the whole building annual energy consumption will not exceed that used by a similar building using similar forms of energy designed in accordance with the prescriptive requirements of this chapter. Compliance under this section allows trade-offs between the performance requirements in all sections of this chapter.

1306.2 Documentation. The applicant shall submit documents showing compliance with the requirements of this chapter. This documentation shall be in a manner approved by the administrator of the Building Codes Division.

SECTION 1307
EXTERIOR ENVELOPE REQUIREMENTS — RESIDENTIAL

1307.1 General. All conditioned spaces within residential buildings shall comply with the requirements of Table 13-A or Table 13-B and Table 13-C and this section.

1307.1.1 Insulation materials. Insulation materials shall be installed per the manufacturer's listing and specifications and this section. Insulation R-values shall be specified as required in 16 CFR Chapter I (1-1-91 Edition) Part 460, *Labeling and Advertising of Home Insulation*.

1307.1.1.1 Loose-fill insulation. Blown, poured and spray-on type insulation complying with Section 707 may be used in attic spaces where the roof slope is 4 units vertical in 12 units horizontal (33.3 percent slope) or greater and there is at least 44 inches (1118 mm) of headroom at the roof ridge. ("Clear headroom" is defined as the distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.) Adequate baffling of the vent opening shall be provided so as to deflect the incoming air above the surface of the installed blown or poured insulation. Baffles shall be of weather-resistant, rigid material capable of retaining the insulation and shall be in place at the time of the framing inspection.

1307.1.1.2 Batt-type insulation. Batt-type insulation shall be installed flush against the warm side of the cavity insofar as practicable.

1307.1.1.3 Insulation protection. Insulation exposed to the exterior shall be protected from physical and solar damage.

1307.1.1.4 Clearances. Recessed light fixtures shall not be installed in cavities intended to be insulated.

Exception: Fixtures designed and labeled as suitable for being installed in direct contact with insulation (i.e., IC rated).

Thermal insulation shall not be installed within 3 inches (76 mm) of any metal chimney or gas vent that is not listed for insulation clearances.

Thermal insulation shall not be installed in a manner to obstruct openings required for attic ventilation.

A permanent sleeve of fine wire mesh screen, sheet metal or other noncombustible material shall be installed to maintain the required clearances.

Cellulose insulation shall conform to *Interim Safety Standard for Cellulose Insulation*, (16 CFR Part 1209) issued by the Consumer Product Safety Commission July 6, 1979 (44FR 39938). For other insulation, see Section 707.

Foam plastic shall be as specified in Section 707.

1307.1.1.5 Below-grade exterior insulation. Below-grade exterior insulation shall meet the following conditions:

1. The insulation shall be a material that is approved for below-grade applications in wet environments.
2. Insulation shall be installed from the top of the footing to the top of the concrete basement wall.
3. Insulation shall be adequately protected from the elements (ultraviolet and mechanical) per the manufacturer's specifications.
4. The top of the insulation shall be installed in a manner to allow water run-off and prevent pooling.

1307.1.1.6 Recessed lighting fixtures. Recessed lighting fixtures installed within the building envelope shall meet one of the following requirements.

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity, and the annular space between the ceiling cutout and lighting fixture shall be sealed.
2. Type IC rated in accordance with ASTM E283 with no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) air movement from the conditioned space to the ceiling cavity, tested at 1.57 psi (75 Pa) pressure difference, and shall be labeled and the annular space between the ceiling cutout and lighting fixture shall be sealed.
3. Type IC rated, installed inside a sealed box constructed from a minimum 0.5-inch-thick (12.7 mm) gypsum wallboard or constructed from a preformed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose.

1307.1.2 Exterior doors. Doors shall be tested according to the requirements of Section 1307.1.3. When calculating the energy performance of the exterior envelope, the area of doors shall be the actual unit size.

Exceptions:

1. Unglazed doors not tested according to the requirements of Section 1307.1.3 shall be assigned a default *U*-factor of 0.54.
2. Sliding glass doors and swinging glass doors shall meet the specifications for glazing and shall be treated as such.
3. Doors that incorporate glazed areas more than 2.5 square feet (0.23 m^2) in area shall be considered windows.

Doors shall meet the air leakage requirements of Section 1307.1.7.

1307.1.3 Windows. All windows shall meet the requirements of Chapter 13, Part II**,** Division II, Residential Fenestrations.

Exceptions:

1. Glazing not exceeding 1 percent of the heated space floor area is exempt from thermal performance requirements and does not need to be included in Table 13-B thermal performance calculations.
2. Glass block assemblies may use a *U*-factor of 0.51.

1307.1.3.1 Air leakage requirements. Windows shall comply with the air leakage requirements of Section 1307.1.7.

Exception: Site-built windows.

1307.1.3.2 Existing buildings. New windows shall have a maximum *U*-factor of 0.40. Windows shall be tested and labeled in accordance with Sections 1323 and 1324.

Exceptions:

1. Skylights allowed under Section 1323.2, Item 4.
2. Glazing not exceeding 1 percent of the heated space floor area may be exempt from the thermal performance testing and labeling and Table 13-B calculations.
3. Where necessary to retain architectural consistency with remaining windows in the building, new windows shall have a maximum *U*-factor of 0.65.

1307.1.4 Walls.

1307.1.4.1 Advanced framing for walls. Advanced framing for walls is an optional construction method. Advanced framing, when used to qualify a design under the requirements of Section 1307.1, shall meet the following requirements:

1. Walls. Walls shall be framed with 2X studs at 24 inches (610 mm) on center and shall include the following, as detailed in Items 2 and 3.
2. Corners and intersections. Exterior wall and ceiling corners shall be fully insulated through the use of two-stud corners and drywall backup clips or other approved technique. Intersections of interior partition walls with exterior walls shall be fully insulated through the use of single backer boards, mid-height blocking with drywall clips or other approved technique.
3. Headers. Voids in headers 1 inch (25 mm) or greater in thickness shall be insulated with rigid insulation that has a value of R-4 per 1 inch (25 mm) or greater. Nonstructural headers (such as in gable end walls) can be eliminated and replaced with insulation to achieve equivalent levels as the surrounding area.

1307.1.4.2 Below-grade walls. Walls enclosing heated spaces below grade shall be insulated from the bottom of the above-grade subfloor downward to the top of the below-grade finished floor.

1307.1.5 Roof/ceiling: Advanced framing for ceilings. Advanced framing for ceilings is an optional construction

method. Advanced framing, when used to qualify a design under the requirements of Section 1307.1, shall meet the following requirements:

Framing techniques shall be used in attics and ceilings to provide full insulating value to the outside of exterior walls. This may be accomplished through the use of extra-depth or oversized trusses, double rafters, special insulation components installed at the edge of the wall or other approved combinations of framing and insulation. The entire surface of the exterior ceiling shall be insulated to the required value including attic hatches, structural members, electrical fixtures (where allowed by the code) and plumbing penetrations.

1307.1.6 Slab-on-grade floors. For slab-on-grade floors, the perimeter of the floor shall be insulated.

The insulation shall extend downward from the top of the slab for a minimum of 24 inches (610 mm) or downward to the bottom of the slab, then horizontally beneath the slab for a minimum total distance of 24 inches (610 mm).

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

1307.1.7 Air leakage. The requirements of this subsection shall apply to all residential buildings and structures and only to those locations separating outdoor ambient conditions from interior spaces heated or mechanically cooled and are not applicable to separation of interior spaces from each other. Compliance with the criteria for air leakage shall be determined by tests based on applicable engineering principles.

1307.1.7.1 Acceptance criteria. Where specified, compliance with air infiltration rates for all exterior windows, swinging doors and sliding glass doors shall be certified using ASTM E283-91, *Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen*. Tests shall be conducted at a differential pressure of 1.57 pounds per square foot (75 Pa) [equivalent to 25 mph (40 km/h) wind condition].

1. Windows — 0.37 cubic feet per minute (cfm) per foot (0.57 L/s per m) of sash crack.
2. Swinging doors — 0.37 cfm per square foot (1.87 L/s per m^2) of door area.
3. Sliding doors — 0.37 cfm per square foot (1.87 L/s per m^2) of door area.

1307.1.7.2 Sealing required. Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations or utility services through walls, floors and roofs and all other openings in the exterior envelope shall be sealed in a manner approved by the building official.

1307.1.8 Moisture control. To ensure the effectiveness of insulation materials and reduce the hazard of decay and other degradation due to condensation within the structure, moisture-control measures shall be included in all buildings and structures or portions thereof regulated by this chapter.

1307.1.8.1 Vapor barriers. Vapor barriers shall be installed on the warm side (in winter) of all insulation as specified in this subsection.

1. Exterior walls. The exterior walls of new buildings shall have a vapor barrier installed when thermal insulation is installed. The warm side vapor barrier shall have a 1-perm dry cup rating or less.

2. Roof/ceiling. In all exterior ceilings without an attic space above, an approved vapor barrier having a 0.5-perm cup rating or less shall be installed on the warm (in winter) side of the insulation. The vapor barrier need not be an integral part of the insulation material. In the ceiling, flanges shall be lapped at the framing members. See Section 1505.3 for required ventilation.

Exception: When insulation is installed in ceilings in an existing structure and ventilation is provided as specified in Section 1505.3, a vapor barrier need not be installed.

3. Floors. The floors of both new and existing buildings shall have installed an approved vapor barrier having a 1-perm dry cup rating or less on the warm (in winter) side of the insulation. The vapor barrier need not be an integral part of the insulation material.

Exception: Slab-on-grade floors need not have a warm-side vapor barrier.

1307.1.8.2 Ground cover. A ground cover shall be installed in the crawl space for both new and existing buildings when insulation is installed. Ground cover shall be 6-mil black polyethylene or other approved material of equivalent perm rating. Ground cover shall be lapped 12 inches (305 mm) at all joints and cover the entire surface area extending the full width and length of the crawl space and turn 12 inches (305 mm) up the foundation wall. Ground cover of 55-pound (25 kg) roll roofing or an approved equal (that is as durable) shall be installed on the ground beneath concrete floor slabs.

SECTION 1308
HEATING, VENTILATING AND AIR-CONDITIONING (HVAC) SYSTEMS — RESIDENTIAL BUILDINGS

1308.1 General. All dwelling units and guest rooms within residential buildings and structures, or portions thereof, shall comply with the minimum requirements for heating, ventilating and air-conditioning (HVAC) systems of this section.

All other conditioned spaces within residential buildings and structures shall comply with Section 1317.

1308.1.1 Insulation of ducts. All duct systems, or portions thereof, exposed to unconditioned spaces shall be insulated according to Table 13-A.

Vapor barriers shall be installed on supply and return ducts in spaces vented to the outside.

1308.1.2 HVAC controls. All HVAC systems shall be provided controls as specified herein.

1308.1.2.1 Temperature. Each heating, ventilating and air-conditioning system shall be provided with at least

one thermostat for the regulation of temperature. Each thermostat shall be capable of being set from 55ºF to 75ºF (13ºC to 24ºC) where used to control heating only, and from 70ºF to 85ºF (21ºC to 29ºC) where used to control cooling only. Where used to control both heating and cooling, it shall be capable of being set from 55ºF to 85ºF (13ºC to 29ºC) and operating the system heating and cooling in sequence. It shall be capable of providing a temperature range of at least 5ºF (3ºC) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

1308.1.2.2 Humidity. If an HVAC system is equipped with a means for adding moisture to maintain specific selected relative humidities in spaces or zones, a humidistat shall be provided. This device shall be capable of being set to prevent new energy from being used to produce space relative humidity above 30 percent. Where a humidistat is used in an HVAC system for controlling moisture removal to maintain specific selected relative humidities in spaces or zones, it shall be capable of being set to prevent new energy from being used to produce a space-relative humidity below 60 percent.

1308.1.2.3 Temperature zoning. Each separate HVAC system shall be provided at least one thermostat for the regulation of space temperature. In addition, a readily accessible manual or automatic means shall be provided to partially restrict or shut off the heating or cooling input to each zone or floor, excluding unheated or uncooled basements and garages.

1308.1.2.4 Setback and shutoff. The thermostat, or an alternative means, such as switch or clock, shall provide a readily accessible manual or automatic means for reducing the energy required for heating and cooling during periods of nonuse or reduced need.

Exceptions:

1. Where it can be shown that setback or shutdown will result in an increase in overall building energy costs.
2. Equipment with full load demand of 2 kilowatts (6,826 Btu/hr) or less may be controlled by readily accessible manual off-hours controls.

Lowering thermostat set points to reduce energy consumption of heating systems shall not cause energy to be expended to reach the reduced setting.

1308.1.2.4.1 Heat pump controls. All heat pump system thermostats shall be capable of automatic setback and limiting the use of supplemental heat during warm-up periods. Thermostats shall be capable of providing at least two programmable setback periods per day. 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.

1308.1.3 Outside combustion air. See the *Oregon Mechanical Specialty Code* for required outside combustion air for masonry fireplaces, factory-built fireplace(s) and factory-built stoves.

1308.1.4 Economizer cooling. Each fan system with mechanical cooling shall have an air economizer system capable of modulating outside air and return dampers to provide up to 85 percent of the design supply air quantity as outdoor air.

Exceptions:

1. Cooling equipment rated at less than 54,000 Btu/hr (15,827 W) total cooling capacity.
2. HVAC systems serving guest rooms or dwelling units.

1308.2 Equipment performance requirements.

1308.2.1 Heat pumps. Split system heat pumps shall have a heating seasonal performance factor (HSPF) of not less than 6.8.

1308.2.2 Furnaces. Gas- and oil-fired furnaces shall have an annual fuel utilization efficiency (AFUE) of not less than 78 percent.

1308.2.3 Packaged terminal air conditioners. Packaged terminal air conditioners shall meet performance requirements as specified in Table 13-N.

1308.2.4 Packaged terminal heat pumps. Packaged terminal heat pumps shall meet performance requirements as specified in Table 13-N.

SECTION 1309
PIPING INSULATION — RESIDENTIAL

All piping serving as part of a heating or cooling system installed to serve residential buildings and within residential buildings shall be thermally insulated as shown in Table 13-D.

Insulation thicknesses are 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 75ºF (24ºC). Minimum insulation thickness shall be increased for materials having R-values less than 4.0 or may be reduced for materials having R-values greater than 4.6 per inch of thickness as follows:

1. For materials with thermal resistance greater than R = 4.6, the minimum insulation thickness may be determined as follows:

$$\text{New Minimum Thickness} = \frac{4.6 \times \text{Table 13 - D Thickness}}{\text{Actual R}}$$

2. For materials with thermal resistance less than R = 4.0, the minimum insulation thickness shall be determined as follows:

$$\text{New Minimum Thickness} = \frac{4.0 \times \text{Table 13 - D Thickness}}{\text{Actual R}}$$

Exceptions: Piping insulation, except when needed to prevent condensation, is not required in any of the following cases:

1. Piping installed within heating, ventilating and air-conditioning equipment.
2. Piping operating at internal temperatures between 55ºF and 120ºF (13ºC and 49ºC).
3. When the heat loss or heat gain of the piping, without insulation, does not increase the energy requirements of the building.
4. Piping installed in basements, cellars or unventilated crawl space with insulated walls in Group R, Division 3 Occupancies.

Where required to prevent condensation, insulation with vapor barriers shall be installed in addition to insulation required above.

SECTION 1310
LIGHTING
RESERVED

DIVISION III — OTHER BUILDINGS

SECTION 1311
OTHER BUILDINGS

1311.1 Alternate method of compliance using the whole building approach. Alternative building systems and equipment designs may be approved by the building official for other buildings. Applicants shall demonstrate that the whole building annual energy consumption will not exceed that used by a similar building using similar forms of energy designed in accordance with the prescriptive requirements of this chapter. Compliance under this section allows trade-offs between the performance requirements in all sections of this chapter using 8,760-hour annual building simulation. The building official may require review of the simulation results by an independent reviewer.

1311.2 Documentation. The applicant shall submit documents showing compliance with the requirements of this chapter. This documentation shall be in a manner approved by the administrator of the Building Codes Division.

SECTION 1312
EXTERIOR ENVELOPE — OTHER BUILDINGS

1312.1 General. The provisions of this section shall apply to conditioned spaces within all other buildings and structures, or portions thereof.

New buildings shall comply with this section and one of the two approaches in Section 1312.2. Additions and alterations shall comply with Section 1312.3.

Demising elements shall meet building envelope requirements specified in this section.

Exceptions:

1. Exterior wall insulation in semiconditioned spaces (see definition in Section 1302).
2. Exterior wall insulation and doors in spaces enclosed in Group S, Division 3 occupancies or Group H, Division 4 occupancies, motor vehicle service station occupancies where each heating system is controlled by a thermostat with a maximum set point of 55ºF (13ºC).
3. Windows installed in demising walls need not meet the shading coefficient requirements of this section.
4. Buildings whose sole source of space conditioning energy is from on-site solar or wind resources.
5. Greenhouses intended primarily for plant propagation.

1312.1.1 Air leakage. Penetrations or through openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weatherstripped or otherwise sealed to limit infiltration and exfiltration.

Doors and operable glazing separating conditioned from unconditioned spaces shall be weatherstripped. Fixed windows and sash in operable windows shall be tight fitting with glass retained by stops with a continuous air seal.

Exception: Openings required to be fire resistant.

Building assemblies used as ducts or plenums shall be sealed, caulked and gasketed to limit air leakage.

Exterior joints around windows and door frames, between wall cavities and window or door frames, between wall and foundation, between wall and roof, between wall panels, at penetrations or utility services through walls, floors and roofs and all other openings in the exterior envelope shall be sealed in a manner approved by the building official.

1312.1.2 Insulation materials and installation. All insulation materials shall be installed according to the manufacturer's instructions to achieve proper densities, maintain clearances and maintain uniform R-values. Access to equipment shall be provided that prevents damaging or compressing the insulation. Refer to Section 1312.2 for performance requirements.

To the maximum extent possible, insulation of the required R-value shall extend over the full component area.

Exception: Access doors and hatches from conditioned spaces to unconditioned spaces

1312.1.2.1 Suspended ceilings. Suspended ceilings shall not be used to separate conditioned spaces from unconditioned spaces.

1312.1.2.2 Recessed light fixtures. Recessed light fixtures shall not be installed in ceilings separating conditioned from unconditioned spaces.

Exception: Fixtures designed and labeled as suitable for being installed in direct contact with insulation (i.e., IC rated).

1312.1.2.3 Batt insulation. Wall batt insulation shall be installed flush with the heated side of the cavity. Floor insulation shall be installed in a permanent manner in substantial contact with the surface being insulated. Floor batt insulation supports shall be installed so spacing is not more than 24 inches (610 mm) on center.

1312.1.2.4 Heated slabs-on-grade. Insulation for heated slabs-on-grade installed inside the foundation wall, shall extend downward from the top of the slab a minimum distance of 24 inches (610 mm) or downward and under the slab for a combined minimum distance of 24 inches (610 mm). Insulation for heated slabs-on-grade installed outside the foundation shall extend downward to a minimum of 24 inches (610 mm) or to the bottom of the thickened slab edge where used as a foundation. Above grade insulation shall be protected from physical or solar damage.

1312.1.3 Windows and doors. All windows shall comply with this section. Refer to Section 1312.2 for performance requirements.

Exceptions:

1. Code-required fire doors and windows.
2. Windows in exterior walls up to 1 percent of the exterior wall area.

1312.1.3.1 *U*-factors. *U*-factors for exterior windows and doors shall include the effects of the window frame

and shall be determined using the commercial size category values listed in Chapter 30 of the 2001 *ASHRAE Handbook of Fundamentals*, Table No. 4, or rated according to the National Fenestration Rating Council (NFRC) 100, 2001 Version 2, *Procedure for Determining Fenestration Product Thermal Performance*. *U*-factors shall be certified through the NFRC Fenestration Thermal Performance Rating Certification and Labeling Program.

1312.1.3.2 Shading coefficient. For calculations, opaque portions of doors shall have a shading coefficient of zero. Shading coefficients for glazing shall be taken from Chapter 30 of the 2001 *ASHRAE Handbook of Fundamentals*, manufacturers' test data, or certified according to NFRC 200, 2001 Edition, *Procedure for Determining Solar Heat Gain Coefficient* (SHGC) at normal incidence. The center of glass values for the shading coefficient at normal incidence may be converted from the SHGC by dividing the SHGC by a factor of 0.87. SHGC shall be certified through the NFRC Certification and Labeling Program.

1312.1.3.3 Certification and labeling. Windows shall be certified and labeled according to the procedures specified in Sections 1312.1.3.1 and 1312.1.3.2. Windows shall have a temporary label not to be removed before inspection.

Exception: Site-built windows shall have a single certificate specifying glazing type, special coatings, spacers, gas fills, center-of-glass and overall *U*-factor and center-of-glass shading coefficient for every type of site-built glass used. These certificates shall be maintained on the job site and made available to the inspector.

1312.1.4 Moisture control. A 1-perm vapor retarder shall be installed on the warm side (in winter) in all exterior floors, walls and ceilings of heated buildings.

Exceptions:

1. Masonry walls with exposed interior surfaces.
2. Slab-on-grade floors need not have a warm-side vapor barrier.
3. The building official may require designed moisture control systems for refrigerated buildings, buildings covering swimming pools or similar buildings with an unusual potential for moisture damage.
4. The building official may accept designed moisture control systems which may include vapor barriers, ventilation, dehumidification or combinations thereof.

A ground cover shall be installed in the crawl space for both new and existing buildings when insulation is installed. Ground cover shall be 6-mil black polyethylene or other approved material of equivalent perm rating. Ground cover shall be lapped 12 inches (305 mm) at all joints and cover the entire surface area extending the full width and length of the crawl space.

1312.2 Thermal performance. All heated or mechanically cooled buildings and structures, or portions thereof, shall be constructed so as to provide the required thermal performance of the various components as set forth in this subsection.

Exception: Glazing up to 1 percent of the exterior wall area is exempt from the *U*-factor and shading coefficient requirements of this code.

Buildings shall comply by using either Section 1312.2.1 or 1312.2.2.

1312.2.1 Prescriptive path approach. Buildings in Zone 1 shall meet the prescriptive path approach if they comply with the values in Table 13-E. Buildings in Zone 2 shall meet the prescriptive path approach if they comply with the values in Table 13-F. Each component (walls, roofs, etc.) shall meet either the *U*-factor standard for the assembly or the *R*-value standard for the insulation in the table.

Glazing and skylight fractions shall be calculated separately for conditioned spaces, semiconditioned spaces, mechanical penthouses and parking garages.

Trade-offs between components or averaging of component *U*-factors is not allowed.

1312.2.2 Simplified trade-off approach. Buildings may demonstrate compliance with the thermal performance standards of this section by using the simplified trade-off approach (STA). The STA is an analytical method to determine if a proposed building has no larger annual heating load through the exterior envelope and no larger annual cooling load through the exterior envelope than a similar building meeting the prescriptive path approach.

1312.3 Additions and alterations.

1312.3.1 Additions. Additions shall meet all requirements that apply to new buildings.

Exceptions:

1. Additions of the same use and occupancy classification as the existing building that increase floor area up to 10 percent of the existing building area, not to exceed 1,000 square feet (93 m^2), if the component *U*-factors, including glazing, are equal to or less than corresponding *U*-factors in the existing building.
2. Additions that have glazing areas and/or skylight areas exceeding the maximum allowed under the prescriptive path and meet all the following requirements:
   - 2.1. The maximum height of the addition shall not exceed 20 feet (6.1 m) measured from the ground floor,
   - 2.2. The maximum floor area of the addition shall not exceed 3,000 square feet (279 m^2) or 15 percent of the existing building ground floor area, whichever is less,
   - 2.3. The center-of-glass *U*-factor shall not exceed 0.30, tested or calculated in the vertical plane,
   - 2.4. The shading coefficient for overhead glazing shall not exceed 0.40, the shading coefficient for vertical glazing shall not exceed 0.57,
   - 2.5. At least 25 percent of the gross area of the exterior wall of the addition shall have a *U*-

factor not to exceed 0.13 in Zone 1 and 0.09 in Zone 2, and

2.6. Any opaque roof/ceiling portions shall have a *U*-factor not to exceed 0.05 or an insulation value not less than *R*-19.

1312.3.2 Alterations. Alterations to the building envelope shall meet the prescriptive requirements of the code. Exterior wall, roof and floor cavities opened or created during alteration shall be ventilated as required by Section 1505.3 and insulated as required by Tables 13-E and 13-F or to the full depth of the cavity, whichever is less.

Exceptions:

1. When up to 25 percent of the glazing in any one wall is being replaced, it may be replaced with glazing with a *U*-factor and shading coefficient equal or better than the existing glazing.
2. Walls and floors without framing cavities need not be insulated.
3. Replacement of an exterior roof membrane where neither roof sheathing or insulation is exposed, or if existing roof insulation is retained below the roof deck.

The addition of heating to an unconditioned space shall require that the entire roof and one-half the opaque wall area meet or exceed the prescriptive path standards described in Section 1312.2.1. The addition of cooling to a heated space does not initiate any requirements to improve the envelope.

SECTION 1313
LIGHTING — OTHER BUILDINGS

1313.1 General. The provisions in this section apply to lighting equipment, related controls and electric circuits serving the interior spaces of other buildings, exterior building facades (including illuminated roofs and other architectural features), and exterior areas, such as entrances, exits, loading docks, illuminated canopies, roads, open parking, exterior retail and landscaping.

Alterations to existing buildings shall comply with Section 1313.6.

Exceptions:

1. Lighting for the following areas:
   1.1. Outdoor athletic facilities.
   1.2. Dwelling units, lodging houses, one- or two-family dwellings and guest rooms.
   1.3. Industrial plants—manufacturing spaces only.
   1.4. Paint shops and painting spray booths.
   1.5. High-risk security areas such as detention facilities, automatic teller machines (ATMs) and night drops.
   1.6. Areas specifically designed for visually disabled people.
   1.7. Tunnels.
2. Lighting equipment used for the following shall be exempt, provided that it is in addition to general lighting and is controlled by an independent control device:
   2.1. Production lighting for theatrical, television, spectator sports and similar performance areas.
   2.2. Decorative, special effect and production lighting for those portions of entertainment facilities, such as theme parks, nightclubs, discos and casinos, where lighting is an essential technical element for the function performed.
   2.3. Lighting equipment for sale.
   2.4. Task lighting for medical and dental purposes.
   2.5. Bench lighting for research laboratories.
   2.6. Lighting to be used solely for indoor plant growth during the hours of 10:00 p.m. to 6:00 a.m.
   2.7. Emergency lighting that is automatically off during normal building operation.
   2.8. Art accent lighting required for art exhibits or displays in galleries, museums and monuments.
   2.9. Sign lighting.
   2.10Nonpermanent lighting.

1313.2 Luminaire wattages. Lighting luminaire wattage shall be determined in the following manner:

1. Incandescent luminaires. The maximum rated lamp wattage permitted in the luminaire shall be the luminaire's wattage for the purpose of this standard.
2. Luminaire wattage shall be input wattages, including lamp and ballast losses, determined from values approved by the building codes administrator. If a nonstandard product or system is used, ANSI input wattages shall be from the manufacturer's literature.
3. For compliance with this chapter, track lighting shall be calculated at 37.5 watts per linear foot (123 W/m) of track or the maximum circuit load as determined by the overcurrent device protecting the track, whichever is less.

1313.3 Lighting controls. All buildings with lighting equipment shall provide and install the controls described in Section 1313.3.

1313.3.1 Interior lighting controls. The following controls are required for interior lighted spaces:

1313.3.1.1 Local shutoff control. At least one local shutoff lighting control shall be provided for every 2,000 square feet (186 m^2) of lit floor area and for all spaces enclosed by walls or ceiling height partitions.

Exceptions:

1. Lighting for warehouses, parking garages or spaces using less than 0.5 watts per square feet (5.4 W/m^2).
2. Lighting systems serving areas that must be continuously lit.
3. Public areas, such as concourses, with switches that are accessible only to authorized personnel.

4. Lighting for contiguous, single-tenant retail spaces.

1313.3.1.2 Automatic shutoff control. Buildings greater than 5,000 square feet (465 m^2) and office occupancies over 2,000 square feet (186 m^2) of contiguous floor area shall be equipped with separate automatic controls to shut off the lighting during unoccupied periods. Automatic controls shall be an occupancy sensor, time switch or other device capable of automatically shutting off lighting that complies with Section 1313.3.1.2.1 or 1313.3.1.2.2.

Offices less than 300 square feet (27.9 m^2), meeting and conference rooms and school classrooms shall be equipped with occupancy sensors that comply with Section 1313.3.1.2.1.

Exceptions:

1. Emergency and pathway lights as required by code.
2. Where the system is serving an area that must be continuously lit.
3. Display and accent lighting, including plug-in, track and display case lighting, shall be separately controlled.
4. Switching for industrial or manufacturing process facilities as may be required for production.
5. Hospitals and laboratory spaces.
6. Areas in which medical or dental tasks are performed.
7. Mechanical and electrical equipment rooms.

1313.3.1.2.1 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. Lighting fixtures controlled by occupancy sensors shall have a wall-mounted, manual switch capable of turning the lights on and off when the space is occupied.

1313.3.1.2.2 Automatic time switches. Automatic time switches shall have a minimum seven-day clock and be capable of being set for seven different day types per week and incorporate an automatic holiday shutoff feature, which turns off all loads for at least 24 hours and then resumes normally scheduled operations. Automatic time switches shall also have the 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 override switching device that:

1. Is readily accessible,
2. Is located so that a person using the device can see the effects of the control,
3. Is manually operated,
4. Allows the lighting to remain on for no more than 2 hours when an override is initiated, and
5. Controls an area not exceeding 2,000 square feet (186 m^2).

1313.3.1.3 Daylighting controls. Daylighting controls meeting the requirements of this section shall be required for all classrooms and atriums.

1313.3.1.3.1 Daylighting requirements for windows. Classrooms and atriums with a window to exterior-wall ratio of 50 percent or greater shall use automatic daylight sensing controls for all permanently installed luminaries 15 feet (4572 mm) inward and 5 feet (1524 mm) on each side of the windows. For the purpose of this section, the window-to-wall ratio is measured on the inside room of the exterior walls.

1313.3.1.3.2 Daylighting requirements for skylights. In classrooms and atriums with skylights, monitors or other fenestration at or above ceiling level, all permanent luminaries within an area equal to the footprint of the ceiling opening plus the floor-to-ceiling height in each direction of the opening, shall be controlled by automatic daylight sensing controls.

1313.3.1.3.3 Automatic daylight sensing controls. When required by this section, automatic daylight sensing controls shall:

1. Be capable of reducing the light output of the controlled luminaries by at least one-half while maintaining a uniform level of illuminance,
2. Provide continuous dimming of the controlled luminaries,
3. Control only luminaires within the daylit area, and
4. Incorporate time-delay circuits to prevent cycling of light level changes of less than three minutes.

Exception: Atriums may utilize step switching or other noncontinuous dimming devices, provided they have adjustable separation (deadband) of on-and-off points to prevent short cycling.

1313.3.2 Exterior and canopy lighting controls. All exterior lighting systems, including those attached to building exterior surfaces, mounted onto or in adjacent structures, attached to poles or mounted onto or in the ground, shall be controlled by photoelectric switches, clock switches or both, which shall be designed and programmed to extinguish lights when daylight is present. Clock switches shall be of an astronomic (seasonal correcting) type with separate programs for each day of the week and shall store energy to maintain timekeeping during power outages. A motion sensor, if used, shall employ a photoelectric switch to prevent operation during the daytime.

1313.4 Interior connected lighting power. The interior connected lighting power shall not exceed the interior power allowance established in either Section 1313.4.1 or 1313.4.2.

Where multiple, independently operating lighting systems serve the same space and are controlled to prevent simultaneous operation, the connected lighting power shall be based on the system with the highest connected lighting power.

1313.4.1 Tenant space power allowance method. The total interior connected lighting power shall not exceed the maxi-

mum power allowance calculated by multiplying the lighting power density(ies) from Table 13-G based on the predominant use by the floor area of the entire tenant space or building.

1313.4.2 Space-by-space method. The total interior connected lighting power shall not exceed the maximum power allowance calculated by multiplying the lighting power density from Table 13-H for each space by the floor area of that space.

1313.5 Exterior lighting. No incandescent or mercury vapor lighting sources shall be used for exterior building lighting.

Exception: Lighting used in or around swimming pools, water features or other locations subject to the requirements of Article 680 of the *National Electrical Code*.

Lighting power requirements for covered parking and storage garage areas shall be included in the interior lighting power of Section 1313.4.

1313.6 Additions and alterations. Lighting systems in additions and alterations shall comply with the provisions of Section 1313.

Exception: Alterations to existing lighting systems that do not replace more than 50 percent of the luminaries in the permitted project and do not increase the existing total connected lighting power.

SECTION 1314
PIPING INSULATION — OTHER BUILDINGS

1314.1 Requirements. All piping serving as part of a heating or cooling system or as part of a circulating service water heating system in other buildings shall be thermally insulated as specified in Table 13-D. See Section 1315.3 for noncirculating service water heating system piping insulation requirements.

Exceptions:

1. Factory-installed piping within listed HVAC equipment.
2. Piping that conveys fluids with a design operating temperature range between 60ºF and 105ºF (16ºC and 41ºC).

1314.2 Alterations. The requirements of this section apply to other buildings where new piping is installed or new insulation is installed on existing piping.

SECTION 1315
SERVICE WATER HEATING EQUIPMENT — OTHER BUILDINGS

1315.1 Requirements. All service water heating equipment, including water heaters, hot water storage tanks and pool heaters, in other buildings shall meet the requirements of this section and the criteria of Table 13-I. Where multiple criteria are listed in the table, all criteria shall be met.

Exception: Storage water heaters and hot water storage tanks having more than 140 gallons (530 L) of storage capacity need not meet the standby loss (SL) or heat loss (HL) requirements of Table 13-I if the tank surface area is thermally insulated to R-12.5 and if a standing pilot light is not used.

1315.2 Related requirements.

1. Showers (See *Plumbing Specialty Code).*
2. Lavatories (See *Plumbing Specialty Code).*
3. Piping insulation (See Section 1314 of this code).
4. Integrated systems. Service water heating equipment used to provide additional functions (e.g., space heating) as part of a combination (integrated) system shall comply with minimum performance requirements for water heating equipment (see also Section 1318.4.1).

1315.3 Noncirculating systems. The first 8 feet (2.4 m) of outlet piping from the hot water storage tank, and the piping between the storage tank and a heat trap, shall be insulated as specified in Table 13-D.

Storage water heaters for noncirculating systems that are not equipped with integral heat traps and that have vertical pipe risers shall be installed with insulated heat traps as close as possible to both the inlet and outlet connections.

Systems without a heat trap to prevent circulation due to natural convection shall be considered circulating systems. See Section 1314.1 for circulating service water heating system piping insulation requirements.

1315.4 Controls.

1315.4.1 Pump operation. Circulating service hot water systems shall be equipped with automatic time switches or other controls that can be set to turn off the system when use of hot water is not required.

Exceptions:

1. Where public health standards require 24 hours per day operation of pumps for uses such as swimming pools, spas and hospitals.
2. Pumps required to operate solar or waste-heat-recovery pool heating systems.

1315.4.2 Electric heat tapes. Electric heat tapes installed to maintain water temperatures in pipes shall have automatic time switches or other controls that can be set to turn off the electricity to the heat tapes when use of hot water is not required.

Exception: Heat tapes installed for freeze protection.

1315.5 Swimming pools, hot tubs and spas. The provisions of this section shall apply to all swimming pools, hot tubs and spas.

1315.5.1 Controls. All spa or hot tub heaters shall be equipped with a readily accessible ON/OFF switch to allow shutting off the operation of the heater without adjusting the thermostat setting and to allow restarting without relighting the pilot light. A humidity control system shall be used to control ventilating systems serving indoor pools.

1315.5.2. Cover. All heated pools, hot tubs or spas shall be equipped with a cover capable of reducing vapor and heat transmission.

1315.5.3 Heat recovery. Heated indoor swimming pools and spas or hot tubs-over 200 square feet (19 m^2) in size shall pro-

vide for energy conservation by at least one of the following methods:

1. The ventilating system shall provide a heat recovery of 70 percent at winter design conditions;
2. Heat recovered through dehumidification shall be used to heat the pool, spa or hot tub room supply air.

   Exception: Pools heated by renewable energy or waste heat recovery sources capable of providing at least 70 percent of the heating energy required over an operating season.

1315.6 Alterations. The requirements of this section apply to other buildings where new water heating equipment, including water heaters, hot water storage tanks and pool heaters, are installed in existing buildings.

SECTION 1316
OTHER EQUIPMENT

1316.1 Distribution transformers.

1316.1.1 Energy efficiency. All distribution transformers shall meet the minimum efficiency levels specified in Tables 13-J and 13-K. All other terms and provisions of National Electrical Manufacturers Association (NEMA) Standard TP 1-1996, *Guide for Determining Energy Efficiency for Distribution Transformers*, shall apply to distribution transformers. These requirements shall apply to transformers within the scope of TP 1-1996.

Exceptions:

1. Liquid-filled transformers below 10kvA.
2. Dry-type transformers below 15 kvA.
3. Drive transformers designed only to operate electronic variable speed AC and DC drives.
4. Rectifier transformers designed only to power rectifier circuits that have nameplate ratings for fundamental frequency and RMS.
5. High harmonic transformers with a K-rating of K-4 or greater that are designed to supply loads with higher than normal harmonic current levels. A licensed engineer shall submit verification of need for harmonic current control.
6. Auto transformers in which the primary and secondary windings are not electrically isolated, and in which secondary voltage is derived from at least a portion of the primary winding as specified by a licensed engineer.
7. Non-distribution transformers, such as those designed as an integral part of an un-interruptible power system (UPS).
8. Transformers with special impedance outside the following ranges: 1.5% to 7.0% for 15 kvA-150 kvA units, 3.0% to 8.0% for 167 kvA-500 kvA units, and 5.0% to 8.0% for 667 kvA-2,500 kvA.
9. Voltage regulating transformers with load tap changing gear.
10. Sealed transformers that are designed to remain hermetically sealed and nonventilated transformers designed to prevent airflow through the transformer.
11. Replacement of an existing transformer where a qualified TP-1 transformer will not fit in the space provided.
12. Transformers feeding circuits dedicated to machine tools and/or welders.
13. Transformers with tap ranges greater than 15% or with frequencies other than 50 to 60 Hz.
14. Grounding transformers that only provide a system ground reference point, or testing transformers that are part of, or supply power to, electrical test equipment.

1316.1.2 Testing. All distribution transformers shall be tested in accordance with National Electrical Manufacturers Association (NEMA) TP 2-1998, *Standard Test Method for Measuring the Energy Consumption of Distribution Transformers*.

1316.1.3 Labeling. All distribution transformers shall be labeled in accordance with National Electrical Manufacturers Association (NEMA) TP 3-2000, *Standard for the Labeling of Distribution Transformer Efficiency.*

1316.1.4 Alterations. Replacement of existing equipment shall meet the requirements of this section.

SECTION 1317
HEATING, VENTILATING AND AIR CONDITIONING (HVAC) — OTHER BUILDINGS

1317.1 General. Heating, ventilating and air-conditioning (HVAC) systems installed in other buildings shall comply with this section and with one of the following paths:

1. Simple systems (packaged unitary equipment) of Section 1317.9, or
2. Complex systems of Section 1317.10.

   Exceptions:

   1. Systems for the removal of flammable vapors or residues.
   2. Systems for conveying dust, stock or refuse by means of air currents.
   3. Systems for manufacturing and industrial processes.

1317.2 Mechanical ventilation. Ventilation shall be provided as specified in the Oregon Mechanical Specialty Code and this section.

1317.2.1 Fume Hoods. Buildings with fume hood systems having a total exhaust rate greater than 15,000 cfm (7 m^3/s) shall include at least one of the following features:

1. Variable air volume hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to 50 percent or less of design values; or
2. Direct makeup (auxiliary) air supply equal to at least 75 percent of the exhaust rate, heated no warmer than 2°F (-17°C) below room set point, cooled to no cooler than 3°F (-16°C) above room set point, no humidification

added, and no simultaneous heating and cooling used for dehumidification control; or

3. Heat recovery systems to precondition makeup air from fume hood exhaust in accordance with Section 1318.3. Exhaust air energy recovery, without using any exception.

1317.2.2Ventilation controls for high occupancy areas. HVAC systems with ventilation air capacities of at least 1,500 CFM and serving areas having an average occupant load factor of 20 or less (as established in Table 1004.1.2) shall include a means to automatically reduce outside air intake below design rates when spaces are partially occupied. Multiple HVAC systems serving a single room with a combined ventilation air capacity of 1,500 CFM and an occupant load factor of 20 or less must also meet this requirement.

Exception: Systems equipped with an energy recovery device with at least 50% recovery effectiveness.

1317.2.3 Enclosed parking garage ventilation controls. In Group S-2 parking garages, other than open parking garages, used for storing or handling automobiles operating under their own power having ventilation exhaust rates 30,000 cfm and greater shall employ automatic carbon monoxide sensing devices. These devices shall modulate the ventilation system to maintain a maximum average concentration of carbon monoxide of 50 parts per million during any eight-hour period, with a maximum concentration not greater than 200 parts per million for a period not exceeding one hour. Such system shall be designed to exhaust a minimum of 14,000 cfm (6,608 L/s) for each operating vehicle, but not less than 2.5 percent (or one vehicle) of the garage capacity. Failures of such devices shall cause the exhaust fans to operate in the on position.

1317.3 Economizer cooling. Each fan system with mechanical cooling shall have an air economizer system capable of modulating outside air and return dampers to provide up to 100 percent of the design supply air quantity as outdoor air.

Exceptions:

1. Systems at locations where the quality of the outdoor air is so poor as to require extensive treatment of the air.
2. Systems serving only residential spaces and hotel or motel guest rooms.
3. Cooling equipment with direct expansion coils rated at less than 54,000 Btu/hr (15,827 W) total cooling capacity. The total capacity of all such units without economizers shall not exceed 240,000 Btu/hr (70,342 W) per building area served by one utility meter or service, or 10 percent of its total installed cooling capacity, whichever is greater. That portion of the equipment serving dwelling units and guest rooms is not included in determining the total capacity of units without economizers.
4. Systems having a water economizer system capable of cooling air by direct and/or indirect evaporation and providing 100 percent of the expected systems cooling load at outside air temperatures of 50ºF (10ºC) dry bulb and 45ºF (7ºC) wet bulb and below.
5. Ground-coupled heat pumps with cooling capacity of 54,000 Btu/hr (15,827 W) or less.
6. Internal/external zone heat recovery is used.

1317.3.1 Pressure relief. The fan system or building envelope shall provide a means of preventing overpressuring of the building envelope during air economizer operation. Drawings shall specifically identify the pressure relief mechanism for each fan system.

1317.3.2 Integration. Economizer systems shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load.

Exceptions:

1. Direct-expansion systems may include controls to reduce the quantity of outdoor air as required to prevent coil frosting, but not less than required by this code, at the lowest step of compressor unloading.
2. Individual direct-expansion units that have a cooling capacity of 15 tons (53 kW) (nominal) or less may use economizer controls that preclude economizer operation whenever mechanical cooling is required simultaneously.

1317.4 HVAC controls.

1317.4.1 System control. Each HVAC system shall include at least one temperature control device.

1317.4.2 Zone temperature controls. The supply of heating and cooling energy to each zone shall be controlled by individual thermostatic controls responding to temperature within the zone.

Exceptions: Independent perimeter systems that offset only envelope heat losses or gains or both may serve one or more zones also served by an interior system with the following limitations:

1. The perimeter system shall include at least one thermostatic control zone for each building exposure having exterior walls facing only one orientation for 50 contiguous feet (15 m) or more.
2. The perimeter system heating and cooling supply shall be controlled by thermostat(s) located within the zone(s) served by the system.

1317.4.2.1 Control capabilities. Where used to control comfort heating, zone thermostatic controls shall be capable of being set locally or remotely down to 55ºF (13ºC).

Where used to control comfort cooling, zone thermostatic controls shall be capable of being set locally or remotely up to 85ºF (29ºC).

Where used to control both comfort heating and cooling, zone thermostatic controls shall be capable of providing a temperature range or dead band of at least 5ºF (3ºC) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum. Variable aire volume (VAV) terminal units shall be programmed to operate at the minimum airflow setting without the addition of reheat when the zone temperature is within the set deadband.

Exceptions:

1. Special occupancy, special usage or code requirements where deadband controls are not ap-

propriate (such as process applications and areas of hospitals normally used by patients).

2. Thermostats that require manual changeover between heating and cooling modes.

1317.4.3 Off-hour controls. HVAC systems shall be equipped with automatic controls capable of accomplishing a reduction of energy use through control setback or equipment shutdown during periods of nonuse or alternative use of the spaces served by the system.

Exceptions:

1. Equipment with full load demands of 2 kW (6826 Btu/hr) or less may be controlled by readily accessible manual off-hour controls.
2. Systems intended to operate continuously.

1317.4.3.1 Automatic shutdown. To provide automatic shutdown, the HVAC system shall be equipped with at least one of the following:

1. Controls that can start and stop the system under different time schedules for seven different day-types per week are capable of retaining programming and time setting during loss of power for a period of at least 10 hours, and include an accessible manual override, or equivalent function, that allows temporary operation of the system for up to two hours.
2. An occupant sensor that is capable of shutting the system off when no occupant is sensed for a period of up to 30 minutes.
3. An interlock to a security system that shuts the system off when the security system is activated.
4. Systems controlled only by manually activated timers with a maximum two-hour operation.

1317.4.3.2 Optimum start controls. Separate HVAC systems with a design supply air capacity exceeding 10,000 cfm (4,720 L/s) shall have controls that are capable of varying the start-up time of the system to just meet the temperature set point at time of occupancy.

1317.4.3.3 Shutoff dampers. Outdoor air supply and exhaust systems shall be equipped with motorized dampers.

Exceptions:

1. Systems with a design outside air intake or exhaust capacity of 300 cfm (141.6 L/s) or less.
2. Combustion air intake.
3. Cooling equipment rated at less than 54,000 Btu/hr (15,827 W) total cooling capacity.
4. Power relief fans with gravity dampers for packaged HVAC systems under 300,000 Btu/h (117,900 W) cooling capacity.
5. Hood vents or ventilators with gravity dampers in buildings less than three stories in height above grade.
6. Ventilation systems serving unconditioned spaces.
7. Type 1 kitchen exhaust hoods.

1317.4.3.3.1 Shutoff damper controls. Dampers for outdoor air supply and exhaust systems shall automatically shut when the systems or spaces served are not in use during building warm-up, cooldown and setback.

Stair and shaft vents shall be capable of being automatically closed during normal building operations and are interlocked to open as required by fire and smoke detection systems.

1317.4.3.3.2 Motorized damper leakage. Outdoor air supply and exhaust air dampers shall have a maximum leakage rate of 4 cfm/ft^2 (2 L/c per m^2) at 1.0 in water gauge when tested in accordance with AMCA 500D 1998.

Exception: Packaged HVAC equipment 20 cfm/ft^2 (10 L/c per m^2) at 1.0 in w.g. when tested in accordance with AMCA 500D 1998

1317.4.4 Heat pump controls. Heat pumps equipped with supplementary heaters shall be installed with controls to prevent heater operation when the heating load can be met by the heat pump alone. Controls shall include microprocessor controls that minimize supplemental heat usage during start-up, set-up and defrost conditions. These controls shall anticipate the 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).

Exception: Supplementary heater operation is permitted during short transient periods of less than 15 minutes, such as start-ups following room thermostat set point advance and during defrost cycles.

A two-stage room thermostat that controls the supplementary heat in its second stage shall be accepted as meeting this requirement.

1317.5 Equipment performance. The requirements of this section apply to equipment and component performance for HVAC systems. Where 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.

Exception: Equipment performance requirements for Group R, Division 3 occupancies shall be as specified in Section 1308.2.

Cooling systems shall not use hot gas bypass or other evaporative pressure control systems unless the system is designed with multiple steps of unloading or continuous capacity modulation. The capacity of hot gas bypass shall be limited as indicated below:

Rated Capacity	Maximum Hot Gas Bypass Capacity (% of Total Capacity)
≤ 240,000 Btu/hr	50%
> 240,000 Btu/hr	25%

Exception: Unitary packaged systems with cooling capacity not greater than 90,000 Btu/hr.

1317.5.1 Electric equipment. HVAC system equipment for which energy input is electric shall have a minimum effi-

ciency no less than values specified in Tables 13-L, 13-M, 13-N and 13-O.

1317.5.2 Combustion heating equipment. All gas- and oil-fired comfort heating equipment shall have combustion efficiency no less than specified in Tables 13-P and 13-Q.

1317.5.3 Heat-operated cooling equipment. Heat-operated cooling equipment shall have a minimum efficiency performance no less than the values specified in Table 13-O. These requirements apply to, but are not limited to, absorption, engine-driven and turbine-driven equipment.

1317.5.4 Heat rejection equipment.

1317.5.4.1 General. Section 1317.5.4.1 applies to heat rejection equipment used in comfort cooling systems such as air-cooled condensors, open cooling towers, closed-circuit cooling towers and evaporative condensors.

Exception: Heat rejection devices included as an integral part of equipment listed in Tables 13-L, 13-M and 13-O.

Heat rejection equipment shall have a minimum efficiency performance not less than values specified in Table 13-R. These requirements apply to all propeller, axial fan and centrifugal fan cooling towers. Table 13-R specifies requirements for air-cooled condensers that are within rating conditions specified within the table.

1317.5.4.2 Variable flow controls. Cooling tower fans shall have control devices that vary flow by controlling leaving fluid temperature or condenser temperature/pressure of the heat rejection device.

1317.6 Piping insulation. See Section 1314.

1317.7 Insulation of ducts. All air-handling ducts and plenums installed as part of an HVAC air distribution system shall be thermally insulated according to Table 13-S based on ductwork type and location.

Exception: Factory-installed plenums, casings or ductwork furnished as a part of HVAC equipment.

Duct insulation materials shall be manufactured specifically for use as heating or cooling duct insulation and shall be installed according to the manufacturer's recommended practices. Duct insulation *R*-values shown in Table 13-S are for insulation as installed and do not include film resistance. Insulation resistance shall be determined in accordance with ASTM C 518-02, *Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*, at a mean temperature of 75ºF (24ºC) at the installed thickness.

For ducts that convey both heated and cooled air, duct insulation shall be the highest *R*-value specified in Table 13-S. Insulation for ducts located outside of the insulated building envelope shall be covered by a vapor barrier having a perm rating not exceeding 0.5 perm.

Where exterior walls of a building are used as plenum walls, wall insulation shall be as required by this section or Section 1312 to the highest specified *R*-value.

1317.8 Duct sealing. See the *Oregon Mechanical Specialty Code* (OMSC).

1317.9 Simple HVAC Systems. To qualify as a simple system, systems shall be one of the following:

1. Air cooled, constant volume packaged unitary equipment, packaged terminal air conditioners and packaged terminal heat pumps that provide heating, cooling or both and that require only external connection to ductwork and energy services.
2. Air cooled, constant volume split systems, which provide heating, cooling or both, with cooling capacity of 54,000 Btu/hr (15,827 W) or less.
3. Ground-coupled heat pumps with cooling capacity of 54,000 Btu/hr (15,827 W) or less.
4. Heating only systems that have a capacity of less than 5,000 cfm (2,360 L/s) or have a minimum outside air supply of less than 70 percent of the total air circulated.

1317.10 Complex HVAC systems. Complex HVAC systems shall be all field-fabricated systems and systems constructed of subsystem components and systems not qualifying under Section 1317.9 (simple systems).

1317.10.1 Controls. Complex systems shall provide controls as specified in Sections 1317.4 and 1318.2.

1317.10.2 Equipment performance. In addition to the requirements of Section 1317.5, equipment in complex systems shall also comply with Section 1318.3.

1317.10.3 Motor efficiency of electric motors serving built-up HVAC systems (fans, compressors, chillers and pumps). Electric motors, which are NEMA Design A & B squirrel-cage T-frame induction permanently wired polyphase motors of 1 horsepower or more and that serve built-up HVAC systems, shall have a nominal full-load motor efficiency no less than corresponding values for energy efficient motors provided in Table 13-T.

Exceptions:

1. Motors used in systems designed to use more than one speed of a multispeed motor.
2. Factory-installed motors for HVAC equipment meeting the equipment efficiency requirements of Section 1317.1.4.

1317.10.3.1 Variable speed drives. Fan and pump motors of 10 horsepower and greater that serve variable flow air or liquid systems shall be controlled by a variable speed drive. This includes custom and packaged air handlers serving variable air volume fan systems, heating and cooling hydronic pumping systems with modulating control valves and cooling tower fans. Variable inlet vanes, throttling valves (dampers), scroll dampers or bypass circuits shall not be allowed.

Exceptions:

1. Axial vane fans with variable pitch control.
2. Dedicated equipment circulation pumps designed to meet minimum flow requirements established by the manufacturer, such as boiler or chiller auxiliary circulation pumps.

3. Cooling towers designed with two motors (main and small auxillary motor) or multi-speed motors.

1317.11 Kitchen hoods. Kitchen makeup air in conjunction with kitchen hoods shall be provided as required by the *Oregon Mechanical Specialty Code*. For each kitchen exhaust system with a total exhaust capacity greater than 5,000 cfm (2,360 L/s), at least 50 percent of the required makeup air shall be (a) unheated or heated to no more than 60°F (15.55°C); and (b) uncooled or evaporatively cooled.

Exception: Where hoods are used to exhaust ventilation air that would otherwise be exhausted by other fan systems. Air transferred from spaces served by other fan systems may not be used if those systems are required to meet either Section 1203.2.12 or 1317.8.3. The occupancy schedule of HVAC system supplying transfer air shall be similar to the kitchen exhaust hood operating schedule.

1317.12 Permanently installed heating systems outside a building. Heating systems installed outside a building shall be radiant, gas-fired systems. Such heating systems shall be controlled by an occupancy sensing device or a timer switch, so that the system is automatically deenergized when no occupants are present.

1317.13 Additions and alterations. The requirements of Sections 1317 and 1318 apply to new HVAC systems and replaced system components.

Either Section 1317.7 or 1317.8, as appropriate, applies to the insulation of new ductwork installed in existing buildings, and to new insulation installed on existing ductwork in existing buildings.

Sections 1317.4 and 1318.2 apply to controls for all new HVAC equipment or systems installed in an existing building.

Exception: Transport energy requirements of Section 1318.3.2 do not apply when any of the following is true:

1. Less than 50 percent of the air distribution system is altered.
2. The air handler is not replaced.
3. It can be demonstrated to the building official that space constraint in an existing building makes this requirement impractical.

The requirements contained in Division I are for the design and installation of complex HVAC controls. Division II contains requirements for the manufacture of fenestration products.

PART II
DIVISION I — COMPLEX SYSTEMS DESIGN REQUIREMENTS

SECTION 1318
GENERAL

1318.1 Purpose. The purpose of this section is to regulate the design and construction of the selection of heating, ventilating and air conditioning (HVAC) and equipment required for the purpose of effective conservation of energy within a building or structure governed by this code.

1318.2 Complex systems controls.

1318.2.1 Simultaneous heating and cooling. 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 reheating, recooling and mixing or simultaneous supply of air that has been previously mechanically heated with air that has been previously mechanically cooled.

Exceptions:

1. Variable air volume (VAV) systems 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. This minimum volume shall be no greater than the larger of the following:
   1.1. Thirty percent of the peak supply volume ;
   1.2. The minimum required to meet ventilation requirements, unless increasing the volume to critical zones (zones with the highest ratio of outside air to total supply air) beyond the minimum ventilation requirements results in a decrease in overall outside air required by the HVAC system. An increase beyond minimum ventilation rates shall not be applied to more than 20 percent of the zones with reheat, on any one system; or
   1.3. 0.4 cfm/ft^2 (2 L/s per m^2) of zone conditioned floor area.
2. Zones where special pressurization relationships or cross-contamination requirements are such that variable air volume systems are impractical, such as some areas of hospitals and laboratories. Systems that use this exception and supply heated or cooled air to multiple zones shall include controls that automatically reset supply air temperatures by representative building loads or by the outside air temperature unless it can be shown that the supply air temperature reset increases overall annual building energy costs.
3. At least 75 percent of the energy for reheating or for providing warm air in mixing systems comes from a site-recovered or site-solar energy source.
4. Zones where specified humidity levels are required to satisfy process needs, such as computer rooms, museums and areas of hospitals.
5. Zones with a peak supply air quantity of 300 cfm (142 L/s) or less.

1318.2.2 Humidity control. If a system is equipped with a means to add moisture to maintain specific humidity levels in a zone or zones, a humidistat shall be provided. This device shall be capable of being set to prevent the use of fossil fuel or electricity to produce relative humidities in excess of 30 percent for comfort purposes. Where a humidistat is used for comfort dehumidification, it shall be capable of being set to prevent the use of fossil fuel or electricity to reduce relative humidities below 60 percent. Humidifiers with preheating devices mounted in the air stream shall be provided with an automatic valve to shut off preheat when humidification is not required.

1318.2.3 Variable air volume system static pressure reset controls. The system static pressure set point shall be reset to the lowest point possible while still providing the required air flow to the zones with the greatest demand.

Exceptions:

1. Systems that are not controlled by a static pressure sensor.
2. Systems without direct digital control of individual zone boxes.

1318.2.4 Chilled and hot water temperature reset controls. Chilled and hot water systems with a design capacity exceeding 300,000 Btu/hr (88 kW) supplying chilled or heated water or both to comfort conditioning systems shall include controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature.

Exceptions:

1. Where the supply temperature reset controls cannot be implemented without causing improper operation of dehumidifying systems.
2. Hydronic systems that use variable flow to reduce pumping energy.

1318.2.5 Supply-air temperature reset controls. Multiple zone HVAC systems must include controls that automatically reset the supply-air temperature in response to representative building loads or to outdoor air temperature. The controls must be capable of resetting the supply air temperature at least 25 percent of the difference between the design supply air temperature and the design room air temperature.

Exceptions:

1. Systems that prevent reheating, recooling or mixing of heated and cooled supply air.
2. 75 percent of the energy for reheating is from site-recovered or site-solar energy sources.

3. Zones with peak supply air quantities of 300 cfm (.14 m^3/s) or less.

1318.2.6 Zone isolation controls. A system serving multiple occupancies or floors in the same building shall be independently zoned and equipped with isolation devices capable of automatically shutting off the supply of conditioned air and outside air to and from each isolated area. Each isolated area shall be controlled independently and satisfy temperature setback (Section 1317.4.2) and optimum start control requirements. The central fan system air volume shall be reduced through fan speed reduction.

Exception: A cooling system less than 240,000 Btu/hr (70 kW) or a heating system with less than 300,000 Btu/hr (88 kW) total capacity.

1318.2.7 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.

Exceptions: 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 square feet (90 m^2).

1318.2.8 Hydronic system controls. The heating of fluids in hydronic systems that have been previously mechanically cooled and the cooling of fluids that have been previously mechanically heated shall be limited in accordance with the following:

1318.2.8.1 Three-pipe system. Hydronic systems that use a common return system for both hot water and chilled water shall be prohibited.

1318.2.8.2 Two-pipe changeover system. Systems that use a common distribution system to supply both heated and chilled water shall meet the following:

1. The system is designed to allow a deadband between changeover from one mode to the other of at least 15°F (-9°C) outside air temperature.
2. The system is designed to operate and is provided with controls that will allow operation in one mode for at least four hours before changing over to the other mode.
3. Reset controls are provided that allow heating and cooling supply temperatures at the changeover point to be no more than 30°F (-1°C) apart.

1318.2.8.3 Hydronic (water loop) heat pump systems. Hydronic heat pumps connected to a common heat pump water loop with central devices for heat rejection (e.g., cooling tower) and heat addition (e.g., boiler) shall meet the following requirements:

1. Controls shall be installed that are capable of providing a heat pump water supply temperature dead band of at least 20°F (-1°C) between initiation of heat rejection and heat addition by the central devices (e.g., tower and boiler).
2. Closed-circuit tower (fluid cooler) shall have either an automatic valve installed to bypass all but a minimal flow of water around the tower (for freeze protection) or low-leakage positive closure dampers.
3. Open-circuit tower installed directly in the heat pump loop shall have an automatic valve installed to bypass all heat pump water flow around the tower. Open-circuit towers used in conjunction with a separate heat exchanger to isolate the tower from the heat pump loop shall be controlled by shutting down the circulation pump on the cooling tower loop.
4. A two-position valve at each hydronic heat pump for hydronic systems having a total pump system power exceeding 10 horsepower.

1318.2.8.4 Variable flow controls. Controls capable of varying pump flow shall be installed on hydronic pumping systems with motors of 10 horsepower and greater.

1318.3 Exhaust air-heat recovery. An exhaust air heat recovery system shall be installed for each HVAC fan system that has all of the following:

1. A design supply air capacity of 10,000 cfm (4,720 L/s) or greater,
2. A minimum outside air supply of 70 percent or greater,
3. At least one exhaust fan rated at 75 percent of the minimum outside air supply.

The heat recovery system shall be capable of increasing the outside air supply temperature at design heating conditions by 20°F (-7°C) in Climate Zone 1 and 30°F (-1°C) in Climate Zone 2. A provision shall be made to bypass or control the heat recovery system to permit air economizer operation as required by Section 1317.3.

Exceptions:

1. HVAC systems with ventilation controls for high occupancy areas per Section 1203.2.12.
2. Laboratory systems meeting Section 1317.2.1.
3. Systems serving spaces that are not cooled and that are heated to less than 55°F (12.78°C).
4. Systems exhausting toxic, flammable, paint exhaust, corrosive fumes or dust.
5. Type 1 kitchen exhaust hoods.
6. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
7. Systems that only provide cooling.

1318.4 Complex systems equipment performance.

1318.4.1 Service water heating functions provided by space heating and cooling equipment. Space heating or cooling equipment used to provide additional functions (e.g., service water heating) as part of a combination (integrated) system shall comply with minimum performance

requirements for the appropriate space heating or cooling equipment category (see also Section 1315.2).

1318.4.2 Air transport energy. The energy demand of each HVAC fan system shall be limited as specified in Sections 1318.4.2.1 and 1318.4.2.2. For the purposes of determining allowable fan motor horsepower, maximum combined fan motor horsepower is the sum of the motor brake horsepower of all fans operating at design conditions, including supply fans, return/exhaust fans and fan-powered terminal units.

Exceptions:

1. Individual HVAC fan systems with total nameplate fan system motor horsepower of 7.5 or less.
2. Individual exhaust fans with nameplate fan horsepower of 1 horsepower or less.
3. Induction/dilution exhaust fans used in hospitals and laboratories.
4. Fan-powered, parallel airflow terminal units where the fan does not operate in cooling mode.

1318.4.2.1 Constant volume fan systems. For fan systems that provide a constant air volume whenever the fans are operating, the power required by the motors for the combined fan system at design conditions shall not exceed Formula CV-1 shown below. This requirement includes two-speed motors.

Formula CV-1 $$BHP = \frac{\text{Design Airflow (CFM)} * 4.3}{4131}$$

Fan systems with filtration systems that have a pressure drop at design air flow in excess of 1 inch water column when the filters are clean, heat recovery or direct evaporative humidifier/cooler may use Formula CV-2:

Formula CV-2 $$BHP = \frac{CFM * (P.D. + 4.3)}{4131}$$

where:

BHP = the maximum combined fan brake motor horsepower.

CFM = the maximum design supply air flow in cubic feet per minute.

PD = the combined pressure drop at design air flow of all filtering systems in excess of 1 inch water column when the filters are clean plus the pressure drop of heat recovery and direct evaporative humidifier/cooler in inches water gauge.

Exception: Hospital and laboratory fan systems that incorporate flow control devices for maintaining precise pressurization control may use Section 1318.4.2.2.

1318.4.2.2 Variable air volume (VAV) fan systems. For fan systems that are able to vary system air volume automatically as a function of load, the power required by the motors for the combined fan system shall not exceed Formula VAV-1 shown below.

Formula VAV-1 $$BHP = \frac{\text{Design Airflow (CFM)} * 6.0}{4131}$$

Fan systems with filtration systems that have a pressure drop at design air flow in excess of 1 inch water column when the filters are clean, heat recovery or direct evaporative humidifier/cooler may use Formula VAV-2:

Formula VAV-2 $$BHP = \frac{CFM * (P.D. + 6.0)}{4131}$$

where:

BHP = the maximum combined fan brake motor horsepower.

CFM = the maximum design supply air flow in cubic feet per minute.

PD = the combined pressure drop at design air flow of all filtering systems in excess of 1 inch water column when the filters are clean plus the pressure drop of heat recovery and direct evaporative humidifier/cooler in inches water gauge and additional pressure drops for hospitals and laboratories that have fully ducted return and/or exhaust systems, or return and/or exhaust airflow control devices or high filtration as specified in the following table:

ADDITIONAL PD FOR HOSPITALS AND LABORATORIES	
Measure	**Additional PD**
Fully ducted return and/or exhaust air systems	0.5 in w.c.
Return and/or exhaust airflow control devices	0.5 in w.c
Filter systems of individual filter efficiency ≥ 85%	0.5 in w.c

1318.4.2.3 Selecting and sizing nameplate motor horsepower. Selected fan motor shall be no larger than the first available motor size greater than the brake horsepower.

Exceptions:

1. **Constant volume fans:** Where the first available motor larger than the brake horsepower has a nameplate rating within 22 percent of the brake horsepower, the next larger nameplate motor size may be selected.
2. **Fans with variable speed:** Where the motor is controlled by a variable speed drive and where the first available motor larger than the brake horsepower has a nameplate rating within 50 percent of the brake horsepower, the next larger nameplate motor size may be selected.

1318.4.2.4 Large volume fan systems. Fan systems over 15,000 cfm (7 m^3/s) that serve single zone areas, including, but not limited to, gymnasiums, cafeterias, auditoriums or warehouses, are required to reduce airflow based on space thermostat heating and cooling demand. A two-speed motor or variable frequency drive shall reduce airflow to a maximum 60 percent of peak airflow or minimum ventilation air requirement as required by Chapter 12, whichever is greater.

Exception: Systems where the function of the supply air is for purposes other than temperature control, such as maintaining specific humidity levels or supplying an exhaust system.

SECTION 1319
RESERVED

DIVISION II — RESIDENTIAL FENESTRATIONS

SECTION 1320
SCOPE

All windows installed in residential buildings shall meet the requirements of this division.

SECTION 1321
DEFINITIONS

For purposes of this section:

1. "Windows produced in low volume" are a manufacturer's product installed in Oregon during a calendar year that do not exceed: 750 windows, 500 glazed doors, 1,000 skylights covered in Sections 1323.2 to 1323.3 and 25 complete solariums.
2. A "manufacturer" produces windows, assembles window components or does both. A "manufacturer" includes its subsidiaries, divisions and all other companies under common control or ownership.

SECTION 1322
INSULATED GLASS CERTIFICATION

Sealed insulated glass units shall conform to, or be in test for, ASTM E744–81, *Standard Practice for Evaluating Solar Absorptive Materials for Thermal Applications*, as Class A under a Sealed Insulated Glass Manufacturers Association (SIGMA) approved certification program and installed in accordance with the SIGMA glazing specifications.

SECTION 1323
WINDOW THERMAL PERFORMANCE DESIGNATION FOR NEW RESIDENTIAL BUILDINGS AND ADDITIONS

The requirements of this section are not intended to waive or supersede any window thermal performance requirements under state or federal laws.

1323.1 Manufactured windows. *U*-factors for manufactured windows shall be determined in accordance with the National Fenestration Rating Council (NFRC) 100–97, *Procedure for Determining Fenestration Product-Thermal Performance* with amendments through January 1, 1999. The *U*-factors shall be certified through the NFRC Fenestration Thermal Performance Rating Certification and Labeling Program described in NFRC's program document LAP Second Edition, April 20, 1996, CAP Second Edition, May 2, 1998 and PCP 1–92 with program interpretations through April 23, 1998. *U*-factors for documenting code compliance shall be the values determined using size AA.

1323.2 Windows products exempt from testing. Thermal performance testing is not required for:

1. Solariums and sunrooms with a minimum of 0.5-inch (12.7 mm) space between the panes.
2. Skylights constituting no more than 10 percent of the total glazing in a residential building.
3. Windows, glazed doors, skylights and solariums produced in low volume.
4. Skylights constructed with wood, thermal break aluminum or aluminum with vinyl frames with a glazing configuration of either: a minimum 0.5-inch (12.7 mm) space between the panes and low-*e* glass; or triple layered acrylic.
5. Glazing not exceeding 1 percent of the heated space floor area.

1323.3 Thermal performance of exempted products. The thermal performance of window products exempted from testing shall be determined by the following procedures:

1. Windows produced in low volume as prescribed in Section 1321, Item 1 are assigned default *U*-factors.
2. Glazed doors produced in low volume as prescribed in Section 1321, Item 2 are assigned default *U*-factors.
3. The procedures specified in 2001 ASHRAE *Handbook of Fundamentals*, Chapter 30, Table 4 using the vertical installation categories or its certified *U*-factor according to the NFRC procedure as specified in Section 1323.1 for the vertical and overhead glazing contained in solariums.
4. The procedures specified in 2001 ASHRAE *Handbook of Fundamentals*, Chapter 30, Table 4 using sloped installation or its certified *U*-factor according to the NFRC procedure as specified in Section 1323.1 for skylights specified in Section 1323.2, Item 2.
5. Skylights specified in Section 1323.2, Item 3 shall be assigned a default *U*-factor of 0.50.

1323.4 Thermal performance validation for windows produced in low volume or site-built. Windows, glazed doors, skylights and solariums produced in low volume and meeting the requirements of this section may validate default *U*-factors:

1. By using Table 13-U for windows.
2. By using Table 13-V for glazed doors.
3. By using Table 13-U for overhead glazing such as those installed in solariums.
4. By assuming a U-0.50 default for skylights not exempted by Section 1323.2, Item 3 when constructed with thermal-break aluminum, wood or vinyl frames, with glazing constructed of either a minimum:
   - 0.5 inch (12.7 mm) airspace between the glazing with low-*e* and argon gas-filled; or
   - of two 0.5 inch (12.7 mm) airspace triple glazing, measured at the center of glazing.

SECTION 1324
THERMAL PERFORMANCE LABELING

The requirements of this section are not intended to waive or supersede any window label or disclosure requirements under state or federal laws.

1324.1 Labeling exemptions. Labels shall be either:

1. A National Fenestration Rating Council (NFRC) certified product; or
2. State-approved for windows produced in low volume.

Labeling is not required for glazing not exceeding 1 percent of the heated space floor area and is exempt from Table 13-B thermal performance calculations.

1324.2 Label description. Except as provided in Section 1324.1, all windows shall have labeling:

1. That is imprinted, not handwritten;
2. Facing the interior of the room;
3. Attached to the window until the building inspector inspects and verifies the labeling; and
4. That lists the *U*-factor or *U*-factor Class.

Exceptions:

1. Labeling is not required for glazing not exceeding 1 percent of the heated space floor area.
2. Portions of labels for windows produced in low volume may be handwritten.

1324.3 Window *U*-factor. Manufactured window labels, shall additionally list the *U*-factor or *U*-factor class.

1324.4 Skylights exempt from thermal performance standards. Labels for skylights exempted from thermal performance standards under Section 1323.2, Item 4 due to its frame and glazing configuration shall:

1. Contain the statement, "This skylight is not required to be tested or evaluated for thermal performance;"
2. State "EXEMPT" in 0.75 inch (20 mm) high letters;
3. Specify "Issued (*Date of issue*);"
4. Specify the skylight components; and
5. Contain the statement, "Under ORS 455.525(4) this skylight is deemed to comply with Oregon's thermal performance standards regardless of *U*-factor."

1324.5 Solariums and skylights exempted from testing. Labels for solariums and sunrooms with 0.5 inch (12.7 mm) airspace between the glazing and skylights less than 10 percent of the total glazing in a dwelling exempt from thermal performance testing under Section 1323.2, Items 1, 2 and 4 shall:

1. Specify the window components and configuration; and
2. Show the *U*-factor determined by Section 1323.3, Item 3.

Exception: Exempt solariums and skylights may be labeled as certified through the NFRC procedure as specified in Section 1323.1.

1324.6 Windows produced in low volume or site-built. Labeling and disclosures:

1324.6.1 Low volume windows and glazed doors. Labels for windows and glazed doors produced in low volume shall:

1. Specify window components;
2. Show the allowed *U*-factor in the appropriate location;
3. Show a production count number that does not exceed the maximums established in Section 1321, Item 1; and
4. Imprint "(*Manufacturer's name*) certifies the attached window is constructed in a manner to obtain the specified *U*-factor."

1324.6.2 Low volume skylights. Labels for skylights produced in low volume, when constructed with thermal-break aluminum, wood or vinyl frames with glazing constructed of either a minimum: 0.5 inch (12.7 mm) airspace between the glazing with low-*e* and argon gas-filled or of two 0.5 inch (12.7 mm) airspace triple glazing, measured at the center of glazing for the *U*-0.50 requirement shall:

1. Specify window components;
2. State "*U*-0.50 Default *U*-factor;"
3. State "Limited Production Skylight Compliance *U*-factor Label" and "Maximum Allowable Skylight Area Shall Not Exceed Two Percent of the Heated Space Floor Area;"
4. Show a production count number that does not exceed the maximums established in Section 1321, Item 1; and
5. Imprint "(*Manufacturer's name*) certifies the attached skylight complies with the criteria specified in the Oregon building codes."

1324.6.3 Other skylights. Labels for skylights produced in low volume, not meeting the construction and configuration requirements of Section 1324.6.2 and not otherwise exempt under Section 1323.2, Item 4, shall:

1. Specify window components;
2. State "Calculated *U*-factor Skylight Compliance Label;"
3. Show the *U*-factor determined by Section 1323.3, Item 4; and
4. Show a production count number that does not exceed the maximums established in Section 1321, Item 1.

1324.6.4 Solariums. Labels for solariums produced in low volume shall:

1. Specify the window components for each of the glazed surfaces, such as the front, overhead and each side;
2. Show a production count number that does not exceed the maximums established in Section 1321, Item 1;
3. Show the *U*-factor determined by Section 1323.4, Items 1 and 3 for each of the glazed surfaces;
4. Imprint "(*Manufacturer's name*) certifies the components of this solarium are constructed in a manner to obtain the specified *U*-factor;" and
5. Have one label providing a description of each of the glazed surfaces.

Exception: Products specified in Sections 1324.6.1, 1324.6.2, 1324.6.3 and 1324.6.4, may be labeled as certified through the NFRC procedure as specified in Section 1323.1.

1324.7 Combined products. When different window types are combined, mulled together by the manufacturer or manufactured to fit a framed rough opening, a single label may be used.

Exception: A solarium shall have one label providing a description of each of the glazed surfaces, such as the front, overhead and each side.

1324.8 Label distribution. Labels under Sections 1323.2 through 1323.4 shall be designed by the division and sold by persons authorized by the agency and shall not be sold in lots exceeding the maximums for each window type per manufacturer during any calendar year.

SECTION 1325
AIR LEAKAGE REQUIREMENTS

Windows shall comply with the air leakage requirements of Section 1307.1.7.

Exception: Site-built windows

SECTION 1326
ALTERATIONS

New windows installed in residences shall meet the requirements of Section 1307.1.3.2.

The following information is repeated for the reader's convenience:

1307.1.3.2 Existing buildings. New windows installed in residential buildings shall have a maximum *U*-factor of 0.40. Windows shall be tested and labeled in accordance with Sections 1323 and 1324.

Exceptions:

1. Skylights allowed under Section 1323.2, Item 4.
2. Glazing not exceeding 1 percent of the heated space floor area may be exempt from thermal performance testing and labeling and Table 13-B calculations.
3. Where necessary to retain architectural consistency with remaining windows in the building, new windows shall have a maximum *U*-factor of 0.65.

TABLE 13-A
PRESCRIPTIVE COMPLIANCE PATHS FOR RESIDENTIAL BUILDINGS[1,2,3]

Building Components	PATH 1	PATH 2 Sun Tempered[4]	PATH 3	PATH 4 Sun Tempered[4]	PATH 5	PATH 6 Sun Tempered[4]	PATH 7 Sun Tempered[4]	PATH 8 House Size Limited[5]	PATH 9 Log Homes/ Solid Timber	PATH 10
Maximum Allowable Window Area[6]	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	12%	No Limit	No Limit
Window Class[7]	U = 0.40	U = 0.40	U = 0.50	U = 0.50	U = 0.60	U = 0.60	U = 0.60	U = 0.40	U = 0.40	U = 0.35
Exterior Doors	U = 0.20[8]	U = 0.20[8]	U = 0.20	U = 0.20	U = 0.20	U = 0.20	U = 0.20[8]	U = 0.20	U = 0.54	U = 0.20[8]
Wall Insulation[9]	R-21[10]	R-15	R-21A[11]	R-15A[11]	R-24A[11]	R-21A[11]	R-21A[11]	R-15	3	R-15
Underfloor Insulation	R-25	R-21	R-25	R-21	R-30	R-21	R-25	R-21	R-30	R-30
Flat Ceilings	R-38	R-49	R-49A[11]	R-38	R-49A[11]	R-49A[11]	R-49A[11]	R-49	R-49	R-49
Vaulted Ceilings[12]	R-30[13]	R-30[13]	R-30[13]	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Skylight Class[7]	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U = 0.50	U=0.50
Skylight Area[14]	< 2%	< 2%	< 2%	< 2%	< 2%	< 2%	< 2%	< 2%	< 2%	< 2%
Basement Walls[15]	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15
Slab Floor Edge Insulation	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15	R-15
Forced Air Duct Insulation	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8	R-8

For SI: 1 square foot = .0929m^2.

1. Path 1 is based on cost effectiveness. Paths 2-7 are based on energy equivalence with Path 1. Cost effectiveness of Paths 2-9 not evaluated.
2. As allowed in current Section 1306, thermal performance of a component may be adjusted provided that overall heat loss does not exceed the total resulting from conformance to the required *U*-factor standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved *U*-factors contained in Table No 13-B and 13-C.
3. *R*-values used in this table are nominal, for the insulation only and not for the entire assembly. The wall component for Path 9 shall be a minimum solid log or timber wall thickness of 3.5 inches (90 mm).
4. The sun-tempered house shall have one lot line that borders on a street within 30 degrees of true east-west and 50 percent or more of the total glazing for the heated space on the south elevation. An approved alternative to street orientation based on solar design and access shall be accepted by the building official.
5. Path 8 applies only to residential buildings with less than 1,500 square feet heated floor space and glazing area less than 12 percent of heated space floor area.
6. Reduced window area may not be used as a trade-off criterion for thermal performance of any component, except as noted in Table 13-B.
7. Window and skylight U-factors shall not exceed the number listed. *U*-factors may also be listed as "class" on some windows and skylights (i.e., CL40 is same as U=0.40).
8. A maximum of 28 square feet of exterior door area per dwelling unit can have a U-factor of 0.54 or less.
9. For detached one- and two-family dwellings, wall insulation requirements apply to all exterior wood framed, concrete or masonry walls that are above grade, including cripple walls and rim joist areas.
10. R-19 advanced frame or 2 x 4 wall with rigid insulation may be substituted if total nominal insulation *R*-value is 18.5 or greater.
11. A = advanced frame construction as defined in Section 1307.1.4 for walls, and Section 1307.1.5 for ceilings.
12. Insulation levels for ceilings that have limited attic/rafter depth such as dormers, bay windows or similar architectural features totaling not more than 150 square feet in area may be reduced to not less than *R*-21. When reduced, the cavity shall be filled (except for required ventilation spaces), and a 0.5 perm (dry cup) vapor retarder installed.
13. Vaulted area, unless insulated to *R*-38, may not exceed 50 percent of the total heated space floor area.
14. The skylight area is a percentage of the heated space floor area. Any glazing in the roof/ceiling assembly above the conditioned space shall be considered a skylight.
15. Below grade wood, concrete, or masonry walls include all walls that are below grade and does not include those portions of such walls that extend more than 24 inches (610 mm) above grade.

TABLE 13-B
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[2]	BASE PATH 1[1]			PROPOSED ALTERNATIVE			
	Areas[3]	U-factor	Areas x U	R-value[4]	Areas[3]	U-factor[5]	Areas x U
Flat ceilings		0.031					
Vaulted ceilings[6]		0.033					
Conventional wood-framed walls		0.060					
Windows[7]		0.40					
Skylights		0.50					
Exterior doors		0.20					
Underfloor		0.032					
Slab edge		(perimeter ft. =) F = 0.528					
CODE UA =				**Proposed UA9 =**			

1. Base path 1 represents Prescriptive Compliance Path 1 from Table 13-A.
2. Performance trade-offs are limited to those listed in column titled BUILDING COMPONENTS. Heat plant efficiency, duct insulation levels, passive and active solar heating, and similar measures may not be considered in this method of calculation.
3. Areas from plan take-offs in square feet. All areas shall be the same for both Base Path 1 and Proposed alternative, except for window areas allowed in note 7 below. The vaulted ceiling area for Base Path 1 shall be the actual area or 50 percent of total heated space floor area, whichever is less. Any vaulted ceiling area in excess of 50 percent for Base Path 1 shall be entered as "Flat ceilings" area. The skylight area for Base Path 1 shall be the actual area or 2 percent of total heated space floor area, whichever is less. Any skylight areas in excess of 2 percent for Base Path 1 shall be entered at 0.40, with "Windows" area. A maximum of 28 square feet (2.6 m^2) of exterior door area per dwelling unit can have a *U*-factor of 0.54 or less and shall not be included in calculations. Default U-factor for an unglazed door is 0.54.
4. Minimum Component Requirements: Walls R-15; Floors R-21; Flat Ceilings R-38; Vaults R-21; Below-Grade Wood, Concrete or Masonry Walls R-15; Slab Edge R-10; Duct Insulation R-8. R-values used in this table are nominal, for the insulation only and not for the entire assembly. Window and skylight *U*-factors shall not exceed 0.65 (CL65). Door U-factors shall not exceed 0.54 (Nominal R-2). The wall component for Path 9 shall be a minimum solid log or timber wall thickness of 3.5 inches (88.9 mm).
5. U-factors for wood frame ceilings, walls and floor assemblies shall be as specified in Table 13-C. *U*- factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.
6. Vaulted area, unless insulated to R-38, may not exceed 50 percent of the total heated space floor area.
7. Component U-factors trade-offs may be made against window area in detached single-family dwellings when window area is less than 13 percent of heated space floor area. The base window area in this case shall be set at 13 percent of the heated space floor area.
8. F =The heat loss coefficient, BTU/hr./ft^2/°F. per foot (w/m^3-k) of perimeter.
9. Proposed UA must be less than or equal to Code UA.

TABLE 13-C
APPROVED DEFAULT U-FACTORS

FLAT CEILINGS[1]		
Insulation	**Type**	**U-Factor**
R-38	Conventional framing	0.031
R-38	= > 8/12 roof pitch	0.028
R-38	Advance framing[3]	0.026
R-49	Conventional framing	0.025
R-49	= > 8/12 roof pitch	0.024
R-47	Advance framing[3]	0.020
VAULTED CEILINGS[1]		
Insulation	**Type**	**U-Factor**
R-21	Rafter framing	0.047
R-30	Rafter framing	0.033
R-38	Rafter framing	0.027
R-21	Scissors truss	0.055
R-30	Scissors truss	0.046
R-38	Scissors truss	0.042
R-49	Scissors truss	0.039
R-30	Advance scissors truss[3]	0.032
R-38	Advance scissors truss[3]	0.026
R-49	Advance scissors truss[3]	0.020
EPS FOAM CORE PANEL VAULTED CEILINGS		
Insulation	**Type**	**U-Factor**
R-29	$8^1/_4$″ EPS foam core panel	0.037
R-37	$10^1/_4$″ EPS foam core panel	0.030
R-44	$12^1/_4$″ EPS foam core panel	0.025
FLOORS[1]		
Insulation	**Type**	**U-Factor**
R-21	Underfloor	0.035
R-25	Underfloor	0.032
R-30	Underfloor	0.028
SLAB-ON-GRADE		
Insulation	**Type**	**F-Factor[6]**
R-10	Slab edge	0.54
R-15	Slab edge	0.52
EPS FOAM CORE PANEL EXTERIOR WALLS		
Insulation	**Type**	**U-Factor**
R-14.88	$4^1/_2$″ EPS foam core panel	0.065
R-22.58	$6^1/_4$″ EPS foam core panel	0.045
R-29.31	$8^1/_4$″ EPS foam core panel	0.035

EXTERIOR WALLS[1]			
Insulation	**Insulation Sheathing**	**Framing**	**U-Factor**
R-15	0	Conventional framing	0.080
R-15	0	Intermediate framing[2]	0.075
R-19	0	Conventional framing	0.065
R-19	0	Intermediate framing[2]	0.063
R-19	0	Advance framing[4]	0.061
R-21	0	Conventional framing	0.060
R-21	0	Intermediate framing[2]	0.058
R-21	0	Advance framing[4]	0.055
R-11	3.5[5]	Conventional framing	0.069
R-11	5[5]	Conventional framing	0.063
R-11	7[5]	Conventional framing	0.055
R-11	3.5[5]	Advance framing[4]	0.067
R-11	5[5]	Advance framing[4]	0.061
R-11	7[5]	Advance framing[4]	0.054
R-13	3.5[5]	Conventional framing	0.064
R-13	5[5]	Conventional framing	0.058
R-13	7[5]	Conventional framing	0.052
R-13	3.5[5]	Advance framing[4]	0.062
R-13	5[5]	Advance framing[4]	0.056
R-13	7[5]	Advance framing[4]	0.050
R-15	3.5[5]	Conventional framing	0.060
R-15	5[5]	Conventional framing	0.055
R-15	7[5]	Conventional framing	0.049
R-15	3.5[5]	Advance framing[4]	0.057
R-15	5[5]	Advance framing[4]	0.052
R-15	7[5]	Advance framing[4]	0.047
R-19	3.5[5]	Conventional framing	0.052
R-19	5[5]	Conventional framing	0.047
R-19	7[5]	Conventional framing	0.043
R-19	3.5[5]	Advance framing[4]	0.049
R-19	5[5]	Advance framing[4]	0.045
R-19	7[5]	Advance framing[4]	0.041
R-21	3.5[5]	Conventional framing	0.048
R-21	5[5]	Conventional framing	0.044
R-21	7[5]	Conventional framing	0.040
R-21	3.5[5]	Advance framing[4]	0.044
R-21	5[5]	Advance framing[4]	0.042
R-21	7[5]	Advance framing[4]	0.038

For SI: 1 inch = 25.4 mm.

1. *U*-factors are for wood frame construction. *U*-factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.
2. Intermediate framing consists of wall studs placed at a minimum 16 inches on-center with insulated headers. Voids in headers shall be insulated with rigid insulation having a minimum *R*-value of 4 per one-inch (w/m^3-k) thickness.
3. Advanced framing construction for ceilings as defined in Section 1307.1.5
4. Advanced framing construction for walls as defined in Section 1307.1.4.1
5. Insulation sheathing shall be rigid insulation material installed continuously over entire exterior or interior of wall (excluding partition walls).
6. F-factor is heat loss coefficient in Btu/hr/°F per lineal foot of concrete slab perimeter.

TABLE 13-D
MINIMUM PIPE INSULATION (INCHES)[1, 2]

FLUID DESIGN OPERATING TEMPERATURE RANGE, °F	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE DIAMETER (IN.)				
	Conductivity Range (Btu-in)/(hr.-ft² °F)	Mean Rating Temperature °F	1 and less	1 ¼ to 2	2 ½ to 4	5 & 6	8 & up
Heating Systems (Steam, Steam Condensate and Hot Water)[3]							
Above 350	0.32-0.34	250	2.5	3.0	3	4.0	4.0
251 - 350	0.29-0.31	200	2.0	2.5	3.0	3.5	3.5
201 - 250	0.27-0.30	150	1.5	1.5	2.0	2	3.5
141 - 200	0.25-0.29	125	1.5	1.5	1.5	1.5	1.5
105 - 140	0.24-0.28	100	1.0	1.0	1.0	1.5	1.5
Domestic and Service Hot Water Systems[4]							
105 and greater	0.24-0.28	100	15	1	1.5	1.5	1.5
Cooling Systems (Chilled Water, Brine and Refrigerant)[3]							
40-55	0.22-0.27	100	0.5	0.75	1.0	1.0	1.0
Below 40	0.22-0.27	100	1.0	1.5	1.5	1.5	1.5

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

1. For insulation outside the stated conductivity range, minimum thickness (T) shall be determined as follows:

$$T = r\{(1 + t/r)^{K/k} - 1\}$$

Where T = minimum thickness (in)
r = actual outside radius of pipe (in)
t = insulation thickness in this table for applicable fluid temperature and pipe size.
K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu-in.[h-ft² ºF]) and
k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

2. These thicknesses are based on energy efficiency considerations only. Issues such as water vapor permeability, surface condensation, or safety considerations sometimes require vapor retarders or additional insulation.
3. Piping insulation is not required between the control valve and coil on run-outs when control valve is located within 4 feet of the coil and pipe diameter is 1 inch or less.
4. Applies to recirculating sections of service or domestic hot water systems and first 8 feet (2.4 mm) from storage tank for noncirculating systems.
5. Piping less than 1 inch in diameter and less than 12 feet in length shall be insulated with $^1/_2$ inch insulation with a minimum conductivity of 0.24 Btu-in/hr-ft² °F.

TABLE 13-E
ENVELOPE PRESCRIPTIVE PATH, OTHER BUILDINGS – CLIMATE ZONE 1

COMPONENT[1]	MAXIMUM CODE VALUE		MINIMUM ASSEMBLY
Windows up to 30% glazing fraction			
Overall U-factor	0.540	or	Fixed window: Double-glazed with 0.5-inch airspace, low-emissivity coating. Curtainwall or operable windows: Double-glazed with 0.5-inch airspace, low-emissivity coating, thermally broken frame.
Shading Coefficient[2]	0.57[2]	or	Tinted outdoor pane
Windows up to 40% glazing fraction			
Overall U-factor	0.370	or	Fixed windows: Double-glazed with 0.5-inch airspace, argon-filled space, low-emissivity coating not greater than 0.05, thermally broken frame. Curtainwall or operable windows: Triple-glazed with 0.5-inch airspace, low-emissivity coating on two surfaces, thermally broken frame.
Shading Coefficient	0.35[2]	or	$^1/_4$-inch-thick glass, low-emissivity coating not greater than 0.05, tinted outdoor pane.
Skylights and glazed smoke vents[3]			
U-factor	1.230	or	Double-glazed with 0.5-inch airspace
Shading Coefficient	0.47[2]		N/A

COMPONENT	MAXIMUM GLAZING FRACTION	MAXIMUM COMPONENT *U*-FACTOR		MINIMUM INSULATION *R*-VALUE
Doors[4]		0.200		
Floors				
Over unconditioned spaces		0.070	or	11
Heated slab edge				7.5
Roofs[5]		0.050	or	19
Walls[6]				
Masonry, with integral insulation[7]	15%	0.300		
Masonry, with integral insulation[8]	40%	0.210		
Masonry or concrete, with interior insulation	40%	0.130	or	11
Masonry or concrete, with continuous exterior insulation	15%	0.300	or	1.4
Masonry or concrete, with continuous exterior insulation	40%	0.210	or	2.8
Frame[9]	40%	0.130	or	13
Other	40%	0.130	or	13
Below-grade walls		0.110	or	7.5

For SI: 1 inch = 25.4 mm.

1. Percent glazing fraction for windows is based on total exterior window area divided by the total exterior wall area including demising walls. Percent area for skylights is based on total skylight and glazed smoke vent rough frame area divided by the total roof area. Glazing limit depends on the overall *U*-factor of the window assembly.
2. The shading coefficient is a center-of-glass value.
3. Maximum skylight area = 6 percent of total roof area.
4. The U-factor is a center-of-panel *U*-factor. The following doors are exempt from door and window *U*-factor and shading coefficient requirements: (1) Entry/exit doors with a leaf width of 4 feet (1.2 m) or less, and (2) overhead coil doors.
5. Opaque smoke vents are exempt from *U*-factor requirements.
6. Minimum weight of masonry and concrete walls = 45 lbs/ft^2 (220 kg/m^2) of wall face area.
7. All cores to be filled. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation.
8. All cores except bond beams must contain rigid insulation inserts approved for use in reinforced masonry walls.
9. Batt insulation installed in metal or wood framed walls shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth.

TABLE 13-F
ENVELOPE PRESCRIPTIVE PATH, OTHER BUILDINGS – CLIMATE ZONE 2

COMPONENT[1]	MAXIMUM CODE VALUE		MINIMUM ASSEMBLY
Windows up to 25% glazing fraction			
Overall *U*-factor	0.500	or	Fixed window: Double-glazed with 0.5-inch airspace, low emissivity coating not greater than 0.1. Curtain wall or operable windows: Double-glazed with 0.5-inch airspace, low-emissivity coating not greater than 0.1, thermally broken frame.
Shading Coefficient	0.57[2]	or	Tinted outdoor pane.
Windows up to 33% glazing fraction			
Overall *U*-factor	0.370	or	Fixed window: Double-glazed with 0.5-inch airspace, argon-filled space, low-emissivity coating not greater than 0.05, thermally broken frame. Curtain wall or operable windows: Project shall only use Maximum Code Value.
Shading Coefficient	0.43[2]	or	$^1/_4$-inch-thick glass, low-emissivity coating not greater than 0.05.
Skylights and glazed smoke vents[3]			
U-factor	1.230	or	Double-glazed with 0.5-inch airspace
Shading Coefficient	0.47[2]		N/A

COMPONENT	MAXIMUM GLAZING FRACTION	MAXIMUM COMPONENT *U*-FACTOR		MINIMUM INSULATION *R*-VALUE
Doors[4]		0.200		
Floors				
Over unconditioned spaces		0.070	or	11
Heated slab edge				10
Roofs[5]		0.050	or	19
Walls[6]				
Masonry, with integral insulation[7]	15%	0.300		
Masonry, with integral insulation[8]	33%	0.160		
Masonry or concrete, with interior insulation	33%	0.090	or	13
Masonry or concrete, with continuous exterior insulation	15%	0.270	or	1.8
Masonry or concrete, with continuous exterior insulation	33%	0.160	or	4.3
Frame[9]	33%	0.090	or	19
Other	33%	0.090	or	19
Below-grade walls		0.110	or	7.5

For SI: 1 inch = 25.4 mm.

1. Percent glazing fraction for windows is based on total exterior window area divided by the total exterior wall area including demising walls. Percent area for skylights is based on total skylight and glazed smoke vent rough frame area divided by the total roof area. Glazing limit depends on the overall *U*-factor of the window assembly.
2. The shading coefficient is a center-of-glass value.
3. Maximum skylight area = 6 percent of total roof area.
4. The U-factor is a center-of-panel *U*-factor. The following doors are exempt from door and window U-factor and shading coefficient requirements: (1) Entry/exit doors with a leaf width of 4 feet (1.2 m) or less, and (2) overhead coil doors.
5. Opaque smoke vents are exempt from *U*-factor requirements.
6. Minimum weight of masonry and concrete walls = 45 lbs/ft^2 (220 kg/m^2) of wall face area.
7. All cores to be filled. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation.
8. All cores except bond beams must contain rigid insulation inserts approved for use in reinforced masonry walls.
9. Batt insulation installed in metal or wood framed walls shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth.

TABLE 13-G
TENANT SPACE METHOD MAXIMUM ALLOWABLE LIGHTING POWER DENSITY (LPD)[1]

Tenant or Building Type[1]	Lighting Power Density (W/ft^2)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.5
Exercise Center	1.0
Fire Station	0.8
Gymnasium	1.1
Healthcare – Clinic	1.0
Hospital	1.2
Hotel[2]	1.0
Library	1.3
Manufacturing Facility, Nonprocess Areas[3]	1.3
Motel[2]	1.0
Motion Picture Theatre	1.2
Multi-Family[2]	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Performing Arts Theater	1.6
Police Station	1.0
Post Office	1.1
Religious Building	1.3
Retail	1.5
School/University	1.1
Service Station Canopies, including all types of vehicle fueling and service (except enclosed garages)	2.0
Sports Arena	1.1
Town Hall	1.0
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For SI: 1 foot = 304.8 mm, 1 square foot = 0.929 m^2.

1. Attached canopies shall be included in the total building or tenant power allowance.
2. Dwelling units and guestrooms are exempt from interior lighting power allowance requirements.
3. Spaces used specifically for manufacturing process are exempt and shall not be included in the lighting power allowance calculations.

TABLE 13-H
SPACE-BY-SPACE METHOD MAXIMUM ALLOWABLE LIGHTING POWER DENSITY (LPD)

Common Space Types	LPD (W/ft²)	Building Specific Space Types (cont'd)	LPD (W/ft²)
Office-enclosed	1.1	Gymnasium/Exercise Center	
Office-open plan	1.1	Playing Area	1.4
Conference/Meeting/Multipurpose	1.3	Exercise Area	0.9
Classroom/Lecture/Training	1.4	Fire Stations	
Lobby	1.3	Fire Station Engine Room	0.8
For Hotel	1.1	Sleeping Quarters	0.3
For Performing Arts Theater	3.3	Post Office–Sorting Area	1.2
For Motion Picture Theater	1.1	Convention Center – Exhibit Space	1.3
Audience/Seating Area	0.9	Library	
For Gymnasium	0.4	Card File & Cataloging	1.1
For Exercise Center	0.3	Stacks	1.7
For Convention Center	0.7	Reading Area	1.2
For Religious Buildings	1.7	Hospital	
For Sports Arenas	0.4	Emergency	2.7
For Performing Arts Theater	2.6	Recovery	0.8
For Motion Picture Theater	1.2	Nurse Station	1.0
For Transportation	0.5	Exam/Treatment	1.5
Atrium–first three floors	0.6	Pharmacy	1.2
Atrium–each additional floors	0.2	Patient Room	0.7
Lounge/Recreation	1.2	Operating Room	2.2
For Hospital	0.8	Nursery	0.6
Dining Area		Medical Supply	1.4
For Hotel/Motel	1.3	Physical Therapy	0.9
For Bar Lounge/Leisure Dining	1.4	Radiology	0.4
For Family Dining	2.1	Laundry–Washing	0.6
Food Preparation	1.2	Automotive–Service/Repair	0.7
Laboratory	1.4	Museum	
Restrooms	0.9	General Exhibition	1.0
Dressing/Locker/Fitting Room	0.6	Restoration	1.7
Corridor/Transition	0.5	Bank/Office–Banking Activity Area	1.5
For Hospital	1.0	Religious Buildings	
For Manufacturing Facility	0.5	Worship–pulpit, choir	2.4
Stairs–active	0.6	Fellowship Hall	0.9
Active Storage	0.8	Retail	
For Hospitals	0.9	Grocery Sales Area	2.0
Inactive Storage	0.3	Jewelry & Art Sales Area	4.0
For Museum	0.8	Other Merchandise Sales Area	2.0
Electrical/Mechanical	1.5	Mall Concourse	1.5
Workshop[1]	1.9	Sports Arena	
		Ring Sports Area	2.7
		Court Sports Area	2.3
Building Specific Space Types		Indoor Plying Field Area	1.4
Canopies		Warehouse	
Under 15 feet in height	1.5	Fine Material Storage	1.4
15 feet and over in height	2.0	Medium/Bulky Material Storage	0.9
		Parking Garage–Garage Area	0.2
Courthouse/Police Station		Transportation	
Courtroom	1.9	Airport–Concourse	0.6
Judges Chambers	1.3	Air/Train/Bus–Baggage Area	1.0
		Terminal–Ticket Counter	1.5

For SI: 1 foot = 304.8 mm, 1 square foot = 0.929 m^2.

1. Spaces used specifically for manufacturing are exempt.

TABLE 13-I
WATER HEATING EQUIPMENT
Minimum Performance

CATEGORY	TYPE	FUEL	INPUT RATING[1]	V_T[1]	INPUT TO V_T RATIO (BTU/GAL)	TEST METHOD	ENERGY FACTOR[2]	THERMAL EFFICIENCY E_T %	STANDBY LOSS %HR[3]
NAECA Covered Water Heating Equipment[3]	All	Electric	≤12 kW	all[4]		DOE Test Proc. 10 CFR, Part 430	≥ 0.93-0.00132V		
	Storage	Gas	≤ 75,000 Btu/hr	all[4]			≥ 0.62-0.0019V		
	Instantaneous	Gas	≤ 200,000 Btu/hr	all			≥ 0.62-0.0019V		
	Storage	Oil	≤ 105,000 Btu/hr[4]	all			≥ 0.59-0.0019V		
	Instantaneous	Oil	≤ 210,000 Btu/hr	all			≥ 0.59-0.0019V		
	Pool Heater	Gas/Oil	All	all		ANSI Z21.56-1989		≥ 78%	
Other Water Heating Equipment[5]	Storage	Electric	All	all		ANSI Z21.10.3, 1990[6]			≤ 0.30+27/V_T
	Storage/ Instantaneous	Gas/Oil	≤ 155,000 Btu/hr[4]	all	< 4,000			≥ 78%	≤1.3+114/V_T
			> 155,000 Btu/hr[4]	all	< 4,000			≥ 78%	≤1.3+95/V_T
				< 10	≥ 4,000			≥ 80%	
				≥ 10	≥ 4,000			≥ 77%	≤ 2.3+67/V_T
Unfired Storage Tanks				all					≤6.5 Btu/ft^2 [7]

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8 ºC + 32, 1 ton = 3517 W.

1. V_T is the storage volume in gallons measured during the test to determine the standby loss. V_T may differ from V, but it is within tolerances allowed by the applicable ANSI Z21 and UL standards. Accordingly, for the purpose of estimating the standby loss requirement using the rated volume shown on the rating plate. V_T should be considered as no less than 0.95 V for gas and oil water heaters and no less than 90 V for electric water heaters.
2. V is rated storage volume in gallons as specified by the manufacturer.
3. Consistent with National Appliance Energy Conservation Act (NAECA) of 1987.
4. DOE test procedures apply to electric and gas storage water heaters with rated volumes > 20 gallons and gas instantaneous water heaters with input ratings of 50,000 to 200,000 Btu/h.
5. All those except water heaters covered by NAECA.
6. When testing an electric storage water heater for standby loss using the test procedure of Section 2.9 of ANSI Z21.10.3-1990, the electrical supply voltage shall be maintained within +/- 1 percent of the center of the voltage range specified on the water heater nameplate. Also, when needed for calculations, the thermal efficiency (ET) shall be 98 percent. When testing an oil water heater the test procedures of Section 2.8 and 2.9 of ANSI Z21.10.3-1990, the following modifications will be made.

   6.1. A vertical length of flue gas outlet of sufficient height to establish the minimum draft specified in the manufacturer's installation instructions. All measurements of oil consumption will be taken by instruments with an accuracy of +/- 1 percent or better.

   6.2. The burner rate shall be adjusted to achieve an hourly Btu input rate within +/- 2 percent of the manufacturer's specified input rate with the CO_2 reading as specified by the manufacturer with smoke no greater than 1 and the fuel pump pressure within +/- 1 percent of the manufacturer's specifications.
7. Heat loss of tank surface area Btu/(hr.-ft^2) based on 80ºF water-air temperature difference.

TABLE 13-J
NEMA CLASS 1 EFFICIENCY LEVELS FOR LIQUID-FILLED DISTRIBUTION TRANSFORMERS[1]

SINGLE PHASE		THREE PHASE	
kVa	Efficiency	KVa	Efficiency
10	98.3%	15	98.0%
15	98.5%	30	98.3%
25	98.7%	45	98.5%
37.5	98.8%	75	98.7%
50	98.9%	112.5	98.8%
75	99.0%	150	98.9%
100	99.0%	225	99.0%
167	99.1%	300	99.0%
250	99.2%	500	99.1%
333	99.2%	750	99.2%
500	99.3%	1,000	99.2%
667	99.4%	1,500	99.3%
833	99.4%	2,000	99.4%
		2,500	99.4%

1. Efficiency is calculated per conditions stated in NEMA Standard TP 1-1996

TABLE 13-K
NEMA CLASS 1 EFFICIENCY LEVELS FOR DRY-TYPE DISTRIBUTION TRANSFORMERS[1]

SINGLE-PHASE EFFICIENCY			THREE-PHASE EFFICIENCY		
kVa	Low Voltage	Medium Voltage	kVa	Low Voltage	Medium Voltage
15	97.7%	97.6%	15	97.0%	96.8%
25	98.0%	97.9%	30	97.5%	97.3%
37.5	98.2%	98.1%	45	97.7%	97.6%
50	98.3%	98.2%	75	98.0%	97.9%
75	98.5%	98.4%	112.5	98.2%	98.1%
100	98.6%	98.5%	150	98.3%	98.2%
167	98.7%	98.7%	225	98.5%	98.4%
250	98.8%	98.8%	300	98.6%	98.5%
333	98.9%	98.9%	500	98.7%	98.7%
500	-	99.0%	750	98.8%	98.8%
667	-	99.0%	1,000	98.9%	98.9%
833	-	99.1%	1,500	-	99.0%
			2,000	-	99.0%
			2,500	-	99.1%

1. Efficiency is calculated per conditions stated in NEMA Standard TP 1-1996

TABLE 13-L
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY REQUIRED[1]	TEST PROCEDURE
Air Conditioners, Air Cooled	Cooling capacity less than 65,000 Btu/h	Split Systems	10.0 SEER[2]	ARI 210/240– 94
		Single Package	9.7 SEER[2]	
	Cooling capacity equal to or greater than 65,000 and less than 135,000 Btu/h	Split System and Single Package	10.3 EER[3,4]	
	Cooling capacity equal to or greater than 135,000 and less than 240,000 Btu/h	Split System and Single Package	9.7 EER[3,5]	ARI 340/360– 93
	Cooling capacity equal to or greater than 240,000 and less than 760,000 Btu/h	Split System and Single Package	9.5 EER[3] 9.7 IPLV[3]	
	Cooling capacity equal to or greater than 760,000 Btu/h	Split System and Single Package	9.2 EER[3] 9.4 IPLV[3]	
Air Conditioners, Water and Evaporatively Cooled	Cooling capacity less than 65,000 Btu/h	Split System and Single Package	12.1 EER	ARI 210/240–94
	Cooling capacity equal to or greater than 65,000 and less than 135,000 Btu/h	Split System and Single Package	11.5 EER[3]	
	Cooling capacity equal to or greater than 135,000 and less than 240,000 Btu/h	Split System and Single Package	11.0 EER[3]	ARI 340/360–93
	Cooling capacity equal to or greater than 240,000 Btu/h	Split System and Single Package	11.0 EER[3] 10.3 IPLV[3]	
Condensing Units, Air Cooled	Cooling capacity equal to or greater than 135,000 Btu/h		10.1 EER 11.2 IPLV	ARI 365-94
Condensing Units, Water or Evaporatively Cooled	Cooling capacity equal to or greater than 135,000 Btu/h		13.1 EER 13.1 IPLV	

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8 ºC + 32, 1 ton = 3517 W.

1. IPLVs are only applicable to equipment with capacity modulation.
2. Minimum efficiency required as of October 1, 2007 shall be 13.0 SEER and 11.6 EER for both split systems and single package.
3. Units with a heating section other than electric resistance heat may deduct 0.2 from the required EERs and IPLVs.
4. Minimum efficiency required as of October 1, 2007 shall be 11.0 EER.
5. Minimum efficiency required as of October 1, 2007 shall be 10.8 EER.

TABLE 13-M
ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUB CATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY REQUIRED[1]	TEST PROCEDURE
Air Cooled (Cooling Mode)	Cooling capacity less than 65,000 Btu/h	Split Systems	10.0 SEER[2]	ARI 210/240– 94
		Single Package	9.7 SEER[2]	
	Cooling capacity equal to or greater than 65,000 and less than 135,000 Btu/h	Split System and Single Package	10.1 EER[3,4]	
	Cooling capacity equal to or greater than 135,000 and less than 240,000 Btu/h	Split System and Single Package	9.3 EER[3,5]	ARI 240/360– 93
	Cooling capacity equal to or greater than 240,000 Btu/h	Split System and Single Package	9.0 EER[3] 9.2 IPLV[3]	
Water Source (Cooling Mode)	Cooling capacity less than 17,000 Btu/h	Entering Water: 86 ºF	11.2 EER	ARI/ISO-13256-1
	Cooling capacity equal to or greater than 17,000 and less than 65,000 Btu/h	Entering Water: 86 ºF	12.0 EER	
	Cooling capacity equal to or greater than 65,000 and less than 135,000 Btu/h	Entering Water: 86 ºF	12.0 EER	
Ground Water Source (Cooling Mode)	Cooling capacity less than 135,000 Btu/h	Entering Water: 59 ºF	16.2 EER	ARI/ISO-13256-1
Ground Source (Cooling Mode)	Cooling capacity less than 135,000 Btu/h	Entering Water: 77 ºF	13.4 EER	ARI/ISO-13256-1
Air Cooled (Heating Mode)	Cooling capacity less than 65,000 Btu/h	Split System	6.8 HSPF[6]	ARI 210/240– 94
		Single Package	6.6 HSPF[6]	
	Cooling capacity equal to or greater than 65,000 and less than 135,000 Btu/h	47°F db/43°F wb Outdoor Air	3.2 COP[7]	
		17°F db/15°F wb Outdoor Air	2.2 COP[8]	
	Cooling capacity equal to or greater than 135,000 Btu/h	47°F db/43°F wb Outdoor Air	3.1 COP[9]	ARI 340/360– 94
		17°F db/15°F wb Outdoor Air	2.0 COP[10]	
Water Source (Heating Mode)	Cooling capacity less than 135,000 Btu/h	68°F Entering Water	4.2 COP	ISO-13256-1
Ground Water Source (Heating Mode)	Cooling capacity less than 135,000 Btu/h	50°F Entering Water	3.6 COP	ISO-13256-1
Ground Source (Heating Mode)	Cooling capacity less than 135,000 Btu/h	32°F Entering Water	3.1 COP	ISO-13256-1

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8 ºC + 32, 1 ton = 3517 W.

1. IPLVs and part load rating conditions are only applicable to equipment with capacity modulation.
2. Minimum efficiency required as of October 1, 2007 shall be 13.0 SEER and 11.6 EER for both split systems and single package.
3. Units with a heating section other than electric resistance heat may deduct 0.2 from the required EERs and IPLVs.
4. Minimum efficiency required as of October 1, 2007 shall be 11.0 EER.
5. Minimum efficiency required as of October 1, 2007 shall be 10.8 EER.
6. Minimum efficiency required as of October 1, 2007 shall be 7.9 HSPF for both split systems and single package.
7. Minimum efficiency required as of October 1, 2007 shall be 3.4 COP.
8. Minimum efficiency required as of October 1, 2007 shall be 2.4 COP.
9. Minimum efficiency required as of October 1, 2007 shall be 3.3 COP.
10. Minimum efficiency required as of October 1, 2007 shall be 2.2 COP.

TABLE 13-N
ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS (PTAC) AND PACKAGED TERMINAL HEAT PUMPS (PTHP) – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY REQUIRED	TEST PROCEDURE
PTAC, Cooling Mode New Construction	All Capacities	95°F db Outdoor Air	12.5–(0.213 × Cap/1000) EER[1]	ARI 310/380–93
PTAC, Cooling Mode Replacements[2]	All Capacities	95°F db Outdoor Air	10.9–(0.213 × Cap/1000) EER[1]	
PTHP (Cooling Mode) New Construction	All Capacities	95°F db Outdoor Air	12.3–(0.213 × Cap/1000) EER[1]	ARI 310/380 - 93
PTHP (Cooling Mode) Replacements[2]	All Capacities	95°F db Outdoor Air	10.8–(0.213 × Cap/1000) EER[1]	
PTHP (Heating Mode) New Construction	All Capacities		3.2 - (0.026 × Cap/1000) COP[1]	
PTHP (Heating Mode) Replacements[2]	All Capacities		2.9 - (0.026 × Cap/1000) COP[1]	

For SI: 1 Btu/hr = 0.2931 W, ºF = 1.8 ºC + 32, 1 ton = 3517 W.

1. Cap means the rated cooling capacity of the product in Btu/h. If the unit capacity is less than 7,000 Btu/h, use 7,000 Btu/h in the calculation. If the unit capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.
2. Replacement efficiencies shall only apply to units with existing sleeves less than 16 inches high and less than 42 inches wide. Replacement units shall be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEW CONSTRUCTION PROJECTS."

TABLE 13-O
WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY REQUIRED[1]	TEST PROCEDURE
Air Cooled, With Condenser, Electrically Operated	Less than 150 tons	2.8 COP 2.8 IPLV	ARI 550-92 or ARI 590-92 as appropriate
	Equal to or greater than 150 tons		
Air Cooled, Without Condenser, Electrically Operated	All Capacities	3.10 COP 3.10 IPLV	
Water Cooled, Electrically Operated, Positive Displacement (Reciprocating)	All Capacities	4.20 COP 4.65 IPLV	ARI 590-92
Water Cooled, Electrically Operated, Positive Displacement (Rotary, Screw and Scroll)	Less than 150 tons	4.45 COP 4.50 IPLV	ARI 550-92 or ARI 590-92 as appropriate
	Equal to or greater than 150 tons and less than 300 tons	4.90 COP 4.95 IPLV	
	Equal to or greater than 300 tons	5.50 COP 5.60 IPLV	
Water Cooled, Electrically Operated, Centrifugal	Less than 150 tons	5.0 COP 5.0 IPLV	ARI 550-92
	Equal to or greater than 150 tons and less than 300 tons	5.5 COP 5.5 IPLV	
	Equal to or greater than 300 tons	6.1 COP 6.1 IPLV	
Air Cooled Absorption, Single Effect	All Capacities	0.60 COP	ARI 560-92
Water Cooled Absorption, Single Effect	All Capacities	0.70 COP	
Absorption Double Effect, Indirect Fired	All Capacities	1.0 COP 1.05 IPLV	
Absorption Double Effect, Direct Fired	All Capacities	1.0 COP 1.0 IPLV	

For SI: °C = [(°F) - 32]/1.8

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

TABLE 13-P
WARM AIR FURNACES, AND COMBINATION WARM AIR FURNACES/AIR-CONDITIONING UNITS, WARM AIR DUCT FURNACES AND UNIT HEATERS – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY REQUIRED	TEST PROCEDURE
Warm Air Furnace, Gas-Fired	Less than 225,000 Btu/h (66kW)	78% AFUE or 80% E_t[1]	DOE 10 CFR, Part 430, App N or ANSI Z21.47-1993
	Equal to or greater than 225,000 Btu/h (66kW)	80% E_c[2]	ANSI Z21.47-1993
Warm Air Furnace, Oil-Fired	Less than 225,000 Btu/h (66kW)	78% AFUE or 80% E_t[1]	DOE 10 CFR, Part 430, App N or UL 727-94
	Equal to or greater than 225,000 Btu/h (66kW)	81% E_t[3]	UL 727-94
Warm Air Duct Furnaces, Gas-Fired	All Capacities	80% E_c[4]	ANSI Z83.9 1990
Warm Air Unit Heaters, Gas-Fired	All Capacities	80% E_c[4]	ANSI Z83.9 1990
Warm Air Unit Heaters, Oil-Fired	All Capacities	80% E_c[4]	UL 731-95

For SI: 1 Btu/hr = 0.2931 W.

1. Combination units with three-phase power or cooling capacity greater than or equal to 65,000 Btu/h (19 kW) may comply with either rating.
2. E_c = Combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion. These units must also include an intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
3. E_t = Thermal efficiency. Units must also include an Intermittent Ignition Device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.
4. E_c = Combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.

TABLE 13-Q
BOILERS, GAS AND OIL-FIRED – MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATINGS CONDITIONS	MINIMUM EFFICIENCY REQUIRED[1,2]	TEST PROCEDURE[3]
Boilers, Gas-Fired	Less than 300,000 Btu/h	Hot Water	80% AFUE	DOE Test Procedure 10 CFR, Part 430 App N
		Steam	75% AFUE	
	Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h	Maximum Capacity[4]	75% E_t	Hydronics Institute Heating Boiler Std. 86
	Greater than 2,500,000 Btu/h[5]	Hot Water	80% E_c	
	Greater than 2,500,000 Btu/h[5]	Steam	80% E_c	
Boilers, Oil-Fired	Less than 300,000 Btu/h		80% AFUE	DOE Test Procedure 10 CFR, Part 430 App N
	Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h	Maximum Capacity[4]	78% E_t	Hydronics Institute Heating Boiler Std. 86
	Greater than 2,500,000 Btu/h[5]	Hot Water	83% E_c	
	Greater than 2,500,000 Btu/h[5]	Steam	83% E_c	
Oil-Fired (Residual)	Equal to or greater than 300,000 Btu/h and less than or equal to 2,500,000 Btu/h	Maximum Capacity[4]	78% E_t	Hydronics Institute Heating Boiler Std. 86
	Greater than 2,500,000 Btu/h[5]	Hot Water	83% E_c	
	Greater than 2,500,000 Btu/h[5]	Steam	83% E_c	

For SI: 1 Btu/hr. = 0.2931 W

1. E_c = Combustion efficiency (100% less flue losses). See reference document for detailed information.
2. E_t = Thermal efficiency. See reference document for detailed information.
3. These requirements apply to all packaged boilers and to all other boilers with rated input of 8,000,000 Btu/h or less. The minimum efficiency requirements for boilers cover all capacities of packaged boilers.
4. Minimum and maximum ratings as provided for and allowed by the unit's controls.
5. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers, and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

TABLE 13-R
HEAT REJECTION EQUIPMENT – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[1,2]	Test Procedure
Propeller or Axial Fan Cooling Towers	All	95ºF Entering Water 85ºF Leaving Water 75ºF wb Outdoor Air	> 38.2 gpm/hp	CTI ATC-105(97) and CTI STD-201(96)
Centrifugal Fan Cooling Towers	All	95ºF Entering Water 85ºF Leaving Water 75ºF wb Outdoor Air	> 20.0 gpm/hp	CTI ATC-105(97) and CTI STD-201(96)
Air Cooled Condensers	All	125ºF Condensing Temperature R-22 Test Fluid 190ºF Entering Gas Temperature 15ºF Subcooling 95ºF Entering db	> 176,000 Btu/h-hp	ARI 460(00)

1. For purposes of this table, cooling tower performance is defined as maximum flow rating of tower divided by the fan nameplate rated motor power.
2. For purposes of this table, air-cooled condenser performance is defined as heat rejected from refrigerant divided by the fan nameplate rated motor power.

TABLE 13-S
MINIMUM INSULATION R-VALUE FOR HVAC DUCT SYSTEMS IN OTHER BUILDINGS

DUCT LOCATION	CLIMATE ZONE	DUCT TYPE		
		Outside Air[1]	Cooling/Return[2]	Heating
Exterior of building	1	—	6.0	8.0
	2	—	8.0	12.0
Vented spaces[3]	All	—	3.5	8.0
Within or below slabs on grade	All	—	—	3.0
Unconditioned spaces & plenums[4]	All	1.9	1.9[5]	3.5
Fully conditioned spaces	All	3.5	—	—

For SI: °C = [(°F) - 32]/1.8

1. Outside Air ducts conveying untempered, outside air.
2. Includes cooling-only, return-air, and tempered-air ducts. Tempered air is within 15°F of conditioned space temperature.
3. Includes unconditioned spaces (attics, crawl spaces, vented mechanical rooms) outside the building envelope.
4. Includes unconditioned, unvented spaces such as unvented mechanical rooms, shafts, or plenums (with or without return air) within the building envelope.
5. Insulation is not required for return-air and tempered-air ductwork in unconditioned spaces.

TABLE 13-T
ENERGY EFFICIENT ELECTRIC MOTORS NOMINAL FULL-LOAD EFFICIENCY

SYNCHRONOUS SPEED (RPM)	OPEN MOTORS	ENCLOSED MOTORS				
	3,000	1,800	1,200	3,600	1,800	1,200
Horsepower	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency	Efficiency
1	—	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	84.0	84.0	85.5	84.0	84.0	86.5
3	84.0	86.5	86.5	85.5	87.5	87.5
5	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	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	93.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	93.6	95.0	94.5	94.5	95.0	95.0
200	94.5	95.0	94.5	95.0	95.0	95.0

TABLE 13-U
APPROVED RESIDENTIAL WINDOW DEFAULT *U*-FACTORS[1,2]

DESCRIPTION[3,4,5,6,7] (inches)	FRAME TYPE[8]		
	ALUM. THERMAL BREAK[9]	WOOD/VINYL	ALUM CLAD WOOD/ REINFORCED VINYL[10]
Double, Clear 1/4	N/A	0.56	0.59
Double, Clear 1/4 + argon	0.63	0.53	0.56
Double, Low-*e4* 1/4	0.61	0.52	0.54
Double, Low-*e2* 1/4	0.58	0.49	0.51
Double, Low-*e1* 1/4	0.55	0.47	0.49
Double, Low-*e4* 1/4 + argon	0.55	0.47	0.49
Double, Low-*e2* 1/4 + argon	0.52	0.43	0.46
Double, Low-*e1* 1/4 + argon	0.50	0.41	0.43
Double, Clear 3/8	0.63	0.54	0.57
Double, Clear 3/8 + argon	0.60	0.51	0.54
Double, Low-*e4* 3/8	0.57	0.48	0.51
Double, Low-*e2* 3/8	0.54	0.45	0.48
Double, Low-*e1* 3/8	0.51	0.43	0.46
Double, Low-*e4* 3/8 + argon	0.53	0.44	0.47
Double, Low-*e2* 3/8 + argon	0.49	0.41	0.44
Double, Low-*e1* 3/8 + argon	0.47	0.39	0.41
Double, Clear 1/2	0.60	0.50	0.54
Double, Clear 1/2 + argon	0.58	0.48	0.51
Double, Low-*e4* 1/2	0.53	0.44	0.47
Double, Low-*e2* 1/2	0.50	0.41	0.44
Double, Low-*e1* 1/2	0.47	0.39	0.42
Double, Low-*e4* 1/2 + argon	0.50	0.42	0.44
Double, Low-*e2* 1/2 + argon	0.46	0.37	0.40
Double, Low-*e1* 1/2 + argon	0.43	0.35	0.38
Triple, Clear 1/4	0.52	0.42	0.44
Triple, Clear 1/4 + argon	0.49	0.39	0.42
Triple, Low-*e4* 1/4	0.50	0.40	0.40
Triple, Low-*e2* 1/4	0.48	0.39	0.41
Triple, Low-*e1* 1/4	0.47	0.38	0.40
Triple, Low-*e4* 1/4 + argon	0.46	0.37	0.39
Triple, Low-*e2* 1/4 + argon	0.43	0.34	0.37
Triple, Low-*e1* 1/4 + argon	0.42	0.34	0.36
Triple, Clear 1/2	0.46	0.37	0.40
Triple, Clear 1/2 + argon	0.45	0.36	0.38
Triple, Low-*e4* 1/2	0.43	0.35	0.37
Triple, Low-*e2* 1/2	0.41	0.32	0.35
Triple, Low-*e1* 1/2	0.39	0.31	0.33
Triple, Low-*e4* 1/2 + argon	0.41	0.32	0.35
Triple, Low-*e2* 1/2 + argon	0.38	030	0.32
Triple, Low-*e1* 1/2 + argon	0.37	0.29	0.31

For SI: 1 inch = 25.4 mm.

1. Subtract 0.02 from the listed default *U*-factor for insulated spacers. Insulated spacer material includes fiberglass, wood and butyl or other material with an equivalent K-value.
2. Solariums may subtract 0.03 from the default *U*-factor.
3. 1/4 inch = a minimum dead air space of 0.25 inch between the panes of glass.
   3/ 8inch = a minimum dead air space of 0.375 inch between the panes of glass.
   Products with air spaces different than those listed above shall use the value for the next smaller air space; i.e. 3/4-inch = 1/2-inch *U*-factor, 7/16-inch = 3/8-inch U-factors, 5/16-inch = 1/4 inch *U*-factor.
4. Low-*e4* (emissivity) shall be 0.4 or less. Low-*e2* (emissivity) shall be 0.2 or less. Low-*e1* (emissivity) shall be 0.1 or less.
5. *U*-factors listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO_2, SF6 and argon/SF6 mixtures. The following conversion factor shall apply to Krypton gas-filled units: 1/4-inch or greater airspace with Krypton gas fill = 1/2-inch airspace with Argon gas-fill.
6. Dividers placed between glazing: The *U*-factors listed shall be used where the divider has a minimum gap of 1/8-inch between the divider and lite of each inside glass surface. Add 0.03 to the listed *U*-factor for true divided Lite windows.
7. "Glass block" assemblies may use a *U*-factor of 0.51.
8. Insulated fiberglass framed products shall use wood/vinyl *U*-factors.
9. Aluminum thermal break = An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
   (a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/hr/ft^2/ºF;
   (b) The thermal break material shall not be less than 0.210 inch; and
   (c) All metal framing members of the product to interior and exterior air must incorporate a thermal break meeting the criteria in (a) and (b) above.
10. Aluminum clad wood windows shall use the *U*-factors listed for aluminum clad wood/reinforced vinyl windows. Vinyl clad windows shall use the *U*-factors listed for wood/vinyl windows. Any vinyl frame window with metal reinforcement in more than one rail shall use the *U*-factors listed for aluminum clad wood reinforced vinyl windows.

TABLE 13-V
APPROVED RESIDENTIAL GLAZED DOOR DEFAULT U-FACTORS[1]

DESCRIPTION[2,3,4,5] (inches)	DOOR MATERIAL			
	INSULATED[6]		WOOD[7]	
	Full-Lite[8,9]	Half-Lite[10,11]	Full-Lite[8]	Half-Lite[10]
Double, Clear 1/4	0.39	0.31	0.47	0.42
Double, Clear 1/4 + argon	0.37	0.30	0.45	0.41
Double, Low-*e4* 1/4	0.36	0.30	0.44	0.41
Double, Low-*e2* 1/4	0.35	0.29	0.43	0.40
Double, Low-*e1* 1/4	0.24	0.28	0.41	0.39
Double, Low-*e4* 1/4 + argon	0.33	0.28	0.41	0.39
Double, Low-*e2* 1/4 + argon	0.31	0.26	0.39	0.38
Double, Low-*e1* 1/4 + argon	0.31	0.26	0.38	0.37
Double, Clear 3/8	0.37	0.30	0.45	0.41
Double, Clear 3/8 + argon	0.36	0.29	0.44	0.41
Double, Low-*e4* 3/8	0.34	0.28	0.42	0.40
Double, Low-*e2* 3/8	0.33	0.28	0.41	0.39
Double, Low-*e1* 3/8	0.21	0.26	0.38	0.37
Double, Low-*e4* 3/8 + argon	0.32	0.27	0.40	0.38
Double, Low-*e2* 3/8 + argon	0.29	0.25	0.37	0.37
Double, Low-*e1* 3/8 + argon	0.29	0.25	0.36	0.36
Double, Clear 1/2	0.36	0.29	0.44	0.41
Double, Clear 1/2 + argon	0.34	0.28	0.42	0.40
Double, Low-*e4* 1/2	0.32	0.27	0.40	0.38
Double, Low-*e2* 1/2	0.30	0.26	0.38	0.37
Double, Low-*e1* 1/2	0.19	0.25	0.36	0.36
Double, Low-*e4* 1/2 + argon	0.30	0.26	0.38	0.37
Double, Low-*e2* 1/2 + argon	0.28	0.25	0.36	0.36
Double, Low-*e1* 1/2 + argon	0.28	0.24	0.34	0.35
Triple, Clear 1/4	0.31	0.26	0.39	0.38
Triple, Clear 1/4 + argon	0.29	0.25	0.37	0.37
Triple, Low-*e4* 1/4	0.30	0.26	0.38	0.37
Triple, Low-*e2* 1/4	0.29	0.25	0.37	0.36
Triple, Low-*e4* 1/4 + argon	0.27	0.24	0.35	0.35
Triple, Low-*e2* 1/4 + argon	0.26	0.24	0.34	0.35

1. Subtract 0.02 from the listed default *U*-factor for insulated spacers. Insulated spacer material includes fiberglass, wood and butyl or other material with an equivalent K-value.
2. 1/4 inch = a minimum dead air space of 0.25 inch between the panes of glass.
   3/8 inch = a minimum dead air space of 0.375 inch between the panes of glass.
   Products with air spaces different than those listed above shall use the value for the next smaller air space; i.e. 3/4-inch = 1/2-inch *U*-factors, 7/16-inch = 3/8-inch *U*-factors, 5/16-inch = 1/4" *U*-factors.
3. Low-*e4* (emissivity) shall be 0.4 or less.
   Low-*e2* (emissivity) shall be 0.2 or less.
   Low-*e1* (emissivity) shall be 0.1 or less.
4. U-factors listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO_2, SF6 and argon/SF6 mixtures.
   The following conversion factor shall apply to Krypton gas-filled units:
   1/4-inch or greater airspace with Krypton gas fill = 1/2-inch airspace with Argon gas-fill.
5. Dividers placed between glazing: The *U*-factors listed shall be used where the divider has a minimum gap of 1/8-inch between the divider and lite of each inside glass surface. Add 0.03 to the listed *U*-factor for true divided Lite windows.
6. Insulated = Any urethane insulated foam core door with a thermal break. Thermal break = A thermal break door shall incorporate the following minimum design characteristics:
   (a) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/hr/ft^2/ºF; and
   (b) The thermal break material shall not be less than 0.210 inch.
7. Wood = Any wood door.
8. Full lite = A door that consists of more than 35-percent glazing.
9. Add 0.05 to the listed *U*-factor for full-lite values if insulated door does not have a thermal break.
10. Half lite = A door that consists of 35 percent or less glazing.
11. Add 0.06 to the listed *U*-factor for half-lite values if the insulated door does not have a thermal break.