CHAPTER 11
ENERGY EFFICIENCY

PART I
ENERGY CONSERVATION

SECTION N1101
SCOPE

N1101.1 General. The provisions of this chapter regulate the exterior envelope; the design, construction and selection of heating, ventilating and air-conditioning systems, and piping insulation, required for the purpose of effective conservation of energy within a building or structure governed by this code.

N1101.2 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 N1101.2.1 through N1101.2.3.

N1101.2.1 Alteration and repair. Alterations and repairs affecting energy conservation measures shall conform to the requirements specified in this chapter.

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

Exception: The minimum component requirements as specified in Footnote c of Table N1104.1(2) may be used to the maximum extent practical.

N1101.2.2 Historic buildings. The building official may modify the specific requirements of this chapter for historic buildings and require in lieu thereof alternate requirements which will result in a reasonable degree of energy efficiency. This modification may be allowed for those buildings specifically designated as historically significant by the state historic preservation office(r) or by official action of a local government.

N1101.2.3 Change of occupancy or use. Alteration and repair of buildings changing use to a one or two-family dwelling may use the minimum component requirements as specified in Footnote c of Table N1104.1(2) to the greatest extent practical.

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.

Exception: The minimum component requirements may be disregarded when thermal performance calculations [Table N1104.1(2)] are completed for change of use to Group R occupancy.

N1101.3 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.

N1101.4 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; R–values of insulating materials; HVAC equipment and system controls and other pertinent data to indicate conformance with the requirements of this chapter.

SECTION N1102
DEFINITIONS

AFUE (ANNUAL FUEL UTILIZATION EFFICIENCY) is 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 is the American Society of Heating, Refrigerating and Air–conditioning Engineers, Inc.

AUTOMATIC is 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.”)

BASEMENT WALL is the opaque portion of walls which encloses a basement and is partially or totally below grade walls.

BELOW GRADE WALLS are 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) is 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 is 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 spaces.

***C* (Thermal Conductance).** See “Thermal Conductance.”

CONDITIONED SPACE is a space within the building which is at least 5 feet (1524 mm) 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.)

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

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EXTERIOR DOOR is 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 is any member or group of members, which defines the exterior boundaries of the conditioned space and which has a slope of 60 degrees or greater with the horizontal plane.

EXTERIOR WINDOW is 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 in some cases capable of being opened and shut. All areas, including frames, in the shell of a conditioned space that let 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 is windows and doors in the exterior envelope. See the definitions for "Exterior Door" and "Exterior Window."

FLOOR AREA is the area included within the surrounding exterior walls of a building or portion thereof, exclusive 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 is 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 and enclose a heated or mechanically cooled space.

HEATED SPACE is 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, or has heating registers or contains heating devices.

HSPF (HEATING SEASONAL PERFORMANCE FACTOR) is 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 is an instrument which measures changes in humidity and controls a device or devices to maintain a desired humidity.

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

***K* (THERMAL CONDUCTIVITY).** See "Thermal Conductivity."

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

OTHER BUILDINGS are all buildings and structures, or portions thereof, that are not defined as residential buildings. See "Residential Buildings."

PERM RATING (DRY CUP) is 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.of 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."

***R_t* (THERMAL RESISTANCE TOTAL).** See "Thermal Resistance Total."

RESIDENTIAL BUILDINGS are buildings and structures, or portions thereof, housing Group R, occupancies which are three stories or less in height.

THERMAL CONDUCTANCE (*C*) is 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*) is the rate of heat flow through 1 square foot (0.0929 m^2) of a homogeneous material 1 inch (25.4 mm) thick when there is a temperature difference of 1ºF (-17.2ºC) 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*) is 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 RESISTANCE TOTAL (*R_t*) is the sum of the resistance for all of the individual components of the assembly, including framing members, multiple layers connections, insulation and air films expressed in (ºF x ft.^{2} x h/Btu).

THERMAL TRANSMITTANCE (*U*) is 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 is an instrument which measures changes in temperature and controls a device or devices to maintain a desired temperature.

***U* (THERMAL TRANSMITTANCE).** See "Thermal Transmittance."

VAPOR BARRIER is a film, duplex paper, aluminum foil, paint coating or other material which 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 is a ceiling with a minimum slope of 2 in 12.

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WINDOW. See "Exterior Window."

ZONE is 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 N1103
ALTERNATIVE SYSTEMS

Alternative building systems and equipment design may be approved by the building official when it can be demonstrated that the proposed annual energy consumption will not exceed that of a similar building with similar forms of energy requirements designed in accordance with the provisions of this chapter.

Proposed alternative designs submitted as requests for exception to the standard design criteria must be accompanied by an energy analysis prepared in accordance criteria specified in Part II, Alternative Systems Analysis.

N1103.1 Design parameters. For calculations under this section, the following design parameters shall apply:

The outside temperature shall be taken from the 99 percent winter temperature values and the 1 percent summer temperature values listed in ASHRAE *Handbook of Fundamentals*. For areas not listed, the designer should obtain the most reliable design temperatures available. Selected values are subject to approval of the building official.

SECTION N1104
EXTERIOR ENVELOPE REQUIREMENTS

N1104.1 General. The intent of this section is to provide minimum requirements for exterior envelope construction.

All conditioned spaces within residential buildings shall comply with the requirements of Table N1104.1(1), or Tables N1104.1(2) and N1104.1(3) and the remainder of Section N1104.

TABLE N1104.1(1)
PRESCRIPTIVE COMPLIANCE PATHS FOR RESIDENTIAL BUILDINGS[a,b,c]

Building Components	Path 1	Path 2 Sun tempered[d]	Path 3	Path 4 Sun tempered[d]	Path 5	Path 6 Sun tempered[d]	Path 7 Sun tempered[d]	Path 8 House size limited[e]	Path 9 Log homes/ solid timber	Path 10
Maximum allowable window area[f]	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit	12%	No Limit	No Limit
Window class[g]	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[h]	U=0.20[h]	U=0.20	U=0.20	U=0.20	U=0.20	U=0.20[h]	U=0.20	U=0.54	U=0.20[h]
Wall insulation[i]	R-21[j]	R-15	R-21A[k]	R-15A[k]	R-24A[k]	R-21A[k]	R-21A[k]	R-15	[c]	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[k]	R-38	R-49A[k]	R-49A[k]	R-49A[k]	R-49	R-49	R-49
Vaulted ceilings[l]	R-30[m]	R-30[m]	R-30[m]	R-38	R-38	R-38	R-38	R-38	R-38	R-38
Skylight class[g]	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[n]	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%	<2%
Below-grade wood, concrete or masonry walls[o]	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

[a] 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.

[b] As allowed in current Section N1104.1, 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*-value standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved *U*-values contained in Table N1104.1(2).

[c] 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).

[d] The sun-tempered house shall have one lot line which 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 alternate to street orientation based on solar design and access shall be accepted by the building official.

[e] Path 8 applies only to residential buildings with less than 1,500 sq. ft. heated floor space AND glazing area less than 12 percent of heated space floor area.

[f] Reduced window area may not be used as a trade-off criterion for thermal performance of any component, except as noted in Table N1104.1(2).

[g] Window and skylight *U*-values shall not exceed the number listed. U-values may also be listed as "class" on some windows and skylights (i.e., CL40 is same as U=0.40).

[h] 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.

[i] Wall insulation requirements apply to all exterior wood framed, concrete or masonry walls that are above grade. This includes cripple walls and rim joist areas.

[j] 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.

[k] A=advanced frame construction as defined in Section N1104.5.1 for walls, and Section N1104.6 for ceilings.

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l 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 (13.9 m^2) 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.

m Vaulted area, unless insulated to R-38, may not exceed 50 percent of the total heated space floor area.

n 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.

o Below-grade wood, concrete or masonry walls includes all walls that are below grade and does not include those portions of such wall that extend more than 24 inches above grade.

TABLE N1104.1(2)
RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS[b]	Base Path 1[a]			Proposed alternative			
	Areas[c]	U-factor	Areas x U	R-value[d]	Areas[c]	U-factor[e]	Areas x U
Flat ceilings Vaulted ceilings[f] Conventional wood-framed walls Windows[g]		0.031 0.033 0.060					
A. If glazing area is greater than 13 percent of heated space floor area	Take-off area	0.40					
B. If glazing is less than 13 percent of heated space floor area and trade-off is desired	13% of floor area	0.40					
Skylights Exterior doors Underfloor Slab edge		0.50 0.20 0.032 (perimeter ft. =) F=0.52[h]					
		CODE UA =				**Proposed UA[i] =**	

a Base path 1 represents Prescriptive Compliance Path 1 from Table N1104.1(1).

b Performance trade-offs are limited to those listed in column 1. Heat plant efficiency, duct insulation levels, passive and active solar heating, and similar measures may not be considered in this method of calculation.

c Areas from plan take-offs. All areas must be the same for both Path 1 and Proposed Alternate, except for window areas allowed in footnote g below. The vaulted ceiling area for Base Path 1 must be the actual area from the plan take-off not to exceed 50 percent of the heated space floor area. Any areas in excess of 50 percent for Base Path 1 must be entered at U-0.031 (R-38) with "Flat Ceilings" area. The skylight area for Base Path 1 must be the actual area from the plan take-off, not to exceed 2 percent of the heated space floor area. Any areas in excess of 2 percent for Base Path 1 must 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 wood door is 0.54.

d 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*-values shall not exceed 0.65 (CL65). Door *U*-values 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).

e *U*-values for wood frame ceilings, walls and floor assemblies shall be as specified in Table N1104.1(3). *U*-values for other assemblies, which include brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE procedures.

f Vaulted area, unless insulated to R-38, may not exceed 50 percent of the total heated space floor area.

g Component *U*-values trade-offs may be made against window area in detached single family dwellings or rowhouses 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.

h F=The heat loss coefficient, BTU/hr./ft.^{2}/^{o}F. per foot (w/m^3-k) of perimeter.

i Proposed UA must be less than or equal to Code UA.

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TABLE N1104.1(3)— APPROVED DEFAULT U-FACTORS

FLAT CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-38	Conventional framing	0.031
R-38	=>8/12 roof pitch	0.028
R-38	Advance framing[c]	0.026
R-49	Conventional framing	0.025
R-49	=>8/12 roof pitch	0.024
R-49	Advance framing[c]	0.020
VAULTED CEILINGS[a]		
Insulation	**Type**	**U-Factor**
R-21	Rafter framings	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[c]	0.032
R-38	Advance scissors truss[c]	0.026
R-49	Advance scissors truss[c]	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[a]		
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[f]**
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[a]			
Insulation	**Insulation Sheathing**	**Framing**	**U-Factor**
R-15	0	Conventional framing	0.080
R-15	0	Intermediate framing[b]	0.075
R-19	0	Conventional framing	0.065
R-19	0	Intermediate framing[b]	0.063
R-19	0	Advance framing[d]	0.061
R-21	0	Conventional framing	0.060
R-21	0	Intermediate framing[b]	0.058
R-21	0	Advance framing[d]	0.055
R-11	3.5[e]	Conventional framing	0.069
R-11	5[e]	Conventional framing	0.063
R-11	7[e]	Conventional framing	0.055
R-11	3.5[e]	Advance framing[d]	0.067
R-11	5[e]	Advance framing[d]	0.061
R-11	7[e]	Advance framing[d]	0.054
R-13	3.5[e]	Conventional framing	0.064
R-13	5[e]	Conventional framing	0.058
R-13	7[e]	Conventional framing	0.052
R-13	3.5[e]	Advance framing[d]	0.062
R-13	5[e]	Advance framing[d]	0.056
R-13	7[e]	Advance framing[d]	0.050
R-15	3.5[e]	Conventional framing	0.060
R-15	5[e]	Conventional framing	0.055
R-15	7[e]	Conventional framing	0.049
R-15	3.5[e]	Advance framing[d]	0.057
R-15	5[e]	Advance framing[d]	0.052
R-15	7[e]	Advance framing[d]	0.047
R-19	3.5[e]	Conventional framing	0.052
R-19	5[e]	Conventional framing	0.047
R-19	7[e]	Conventional framing	0.043
R-19	3.5[e]	Advance framing[d]	0.049
R-19	5[e]	Advance framing[d]	0.045
R-19	7[e]	Advance framing[d]	0.041
R-21	3.5[e]	Conventional framing	0.048
R-21	5[e]	Conventional framing	0.044
R-21	7[e]	Conventional framing	0.040
R-21	3.5[e]	Advance framing[d]	0.044
R-21	5[e]	Advance framing[d]	0.042
R-21	7[e]	Advance framing[d]	0.038

[a] *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.

[b] 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.

[c] Advanced framing construction for ceilings as defined in Section 1104.6

[d] Advanced framing construction for walls as defined in Section 1104.5.1

[e] Insulation sheathing shall be rigid insulation material, installed continuously over entire exterior or interior of wall (excluding partition walls).

[f] *F*-Factor is heat loss coefficient in Btu/hr/F° per lineal foot of concrete slab perimeter.

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N1104.2 Insulation materials. Insulation materials shall be installed per manufacturer's listing and specifications and this section. Insulation R–values shall be specified as required in 16 CFR Ch. I (1–1–91 Edition) Part 460—Labeling and Advertising of Home Insulation. Some general requirements for insulation are:

N1104.2.1 Loose–fill insulation. Blown, poured and spray–on type insulation complying with Section R320 may be used in attic spaces where roof slope is 4 units vertical in 12 units horizontal (33.3% 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 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 framing inspection.

N1104.2.2 Batt–type insulation. Batt–type insulation shall be installed flush against the warm side of the cavity insofar as practicable.

N1104.2.3 Insulation protection. Insulation exposed to the exterior shall be protected from physical and solar damage.

N1104.2.4 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., insulation coverage (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 that would 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 R320.

Foam plastic shall be as specified in Section R318.

N1104.2.5 Below grade exterior insulation. Below grade exterior insulation shall meet the following conditions:

1. The insulation shall be a materials 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 manufacturer's specifications.
4. The top of the insulation shall be installed in a manner to allow water run-off and prevent pooling.

N1104.2.6 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, at 1.57 psi pressure (75 Pa) 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.

N1104.3 Exterior doors. Doors shall be tested according to the requirements of Section N1104.4. When calculating the energy performance of the exterior envelope, the area of doors shall be the actual unit size.

Exceptions: 1. Unglazed doors that are not tested according to the requirements of Section N1104.4 shall be assigned a default *U*–value 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 m2) in area shall be considered windows.

Doors shall meet the air leakage requirements of Section N1104.8.

N1104.4 Windows. All windows installed in Oregon shall meet the requirements of Part II, Fenestration Standard.

1. Decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area is exempt from thermal performance requirements and do not need to be included in Table N1104.1(2) thermal performance calculations.

2. Glass block assemblies may use a *U*-value of 0.51.

N1104.4.1 Thermal performance labeling. Labels shall be either:

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

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. List the *U*-value or *U*-value class.

Exceptions:

1. Labeling is not required for decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area.

2. Portions of labels for windows produced in low volume may be handwritten.

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N1104.4.2 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.

N1104.4.3 Air leakage requirements. Windows shall comply with the air leakage requirements of Section N1104.8.

Exception: Site–built windows.

N1104.4.4 Alterations. New windows shall have a maximum *U*–factor of 0.40.

Exceptions: 1. Decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area may be exempt from thermal performance requirements and Table N1104.1(2) calculations.

2. Where necessary to retain architectural consistency with remaining windows in the building, new windows shall have a maximum U-value of 0.65.

N1104.5 Walls.

N1104.5.1 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 N1104.1, 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 (25.4 mm) or greater in thickness shall be insulated with rigid insulation that has a value of R–4 per 1 inch (25.4 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.

N1104.5.2 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.

N1104.6 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 N1104.1, 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.

N1104.7 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.

N1104.8 Air leakage. The requirements of this subsection shall apply only to those locations separating outdoor ambient conditions from interior spaces that are 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.

N1104.8.1 Acceptance criteria. Where specified, compliance with air infiltration rates for all exterior windows, swinging doors and sliding glass doors shall be certified using ASTM E 283 "Standard Test Methods for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors." 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 (0.17 L/s per m) of sash crack.
2. Swinging doors — 0.37 cfm per square foot (0.17 L/s per m^2) of door area.
3. Sliding doors — 0.37 cfm per square foot (0.17 L/s per m^2) of door area.

N1104.8.2 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.

N1104.9 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.

N11014.9.1 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

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be an integral part of the insulation material. In the ceiling, flanges shall be lapped at the framing members. See Section R806 for required ventilation.

Exception: When insulation is installed in ceilings in an existing structure and ventilation is provided as specified in Section R806, 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.

N1104.9.2 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 (0.15 mm) 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 full width and length of the crawl space and turn 12 inches (305 mm) up the foundation wall. Ground cover of 6–mil (0.15 mm) polyethylene or an approved equal (that is as durable) shall be installed on the ground beneath concrete floor slabs located in conditioned spaces.

SECTION N1105
HEATING, VENTILATING AND AIR–CONDITIONING SYSTEMS

This section applies only to one- and two-family dwellings and group R occupancies, three stories and less in height. See Section1313 of the *Oregon Structural Specialty Code* for Group R not covered in this code for HVAC system requirements.

N1105.1 General. This section provides minimum requirements for heating, ventilating and air-conditioning systems.

N1105.2 Insulation of ducts. All duct systems, or portions thereof, exposed to unconditioned spaces shall be insulated according to Table N1104.1(1).

N1105.3 HVAC controls. All heating, ventilating and air–conditioning systems shall be provided controls as specified herein.

N1105.3.1 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 shall be capable of operating the system heating and cooling in sequence. It shall be capable of providing a temperature range of at least 5ºF (-15ºC) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

N1105.3.2 Humidity. If a heating, ventilating and air–conditioning 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 a heating, ventilating and air–conditioning 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.

N1105.3.3 Temperature zoning. Each separate heating, ventilating and air–conditioning system shall be provided at least one thermostat for 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.

N1105.3.4 Setback and shutoff. The thermostat, or an alternate 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 not result in a decrease in overall building energy.

2. Equipment with full load demand of 2 kilowatt (6.826 Btu/H) or less may be controlled by readily accessible off-hour controls.

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

N1105.3.4.1 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.

N1105.4 Outside combustion air. See Section R1005 for required outside combustion air for masonry fireplaces, factory–built fireplace(s) and factory–built stoves.

1105.5 Equipment performance requirements.

N1105.5.1 Heat pumps. Split system heat pumps shall have a heating seasonal performance factor (HSPF) of not less than 6.8.

N1105.5.2 Furnaces. Gas– and oil–fired furnaces shall have an annual fuel utilization efficiency (AFUE) of not less than 78 percent.

N1105.5.3 Packaged terminal air conditioners. Packaged terminal air conditioners shall meet performance requirements as specified in Table N1105.5.3.

N1105.5.4 Packaged terminal heat pumps. Packaged terminal heat pumps shall meet performance requirements as specified in Table N1105.5.3.

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1105.6 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.

3. One and two-family dwellings

TABLE N1105.5.3—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–(0.213x Cap/1000) EER[a]	ARI 310/380–93
PTAC, Cooling Mode Replacements[b]	All Capacities	95°F db Outdoor Air	10.9–(0.213x Cap/1000) EER[a]	
PTHP (Cooling Mode) New Construction	All Capacities	95°F db Outdoor Air	12.3–(0.213x Cap/1000) EER[a]	ARI 310/380–93
PTHP (Cooling Mode) Replacements[b]	All Capacities	95°F db Outdoor Air	10.8–(0.213x Cap/1000) EER[a]	
PTHP (Heating Mode) New Construction	All Capacities		3.2 - (0.026 x Cap/1000) COP[a]	
PTHP (Heating Mode) Replacements[b]	All Capacities		2.9 - (0.026 x Cap/1000) COP[a]	

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

[a] 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.

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

SECTION N1106
PIPING INSULATION

1106.1 Heating and cooling systems. All piping serving as part of a heating or cooling system shall be thermally insulated as shown in Table N1106.1.

1106.2 Domestic and service hot water systems. All piping serving as part of a domestic or service hot water system shall be thermally insulated as shown in Table N1106.1.

Exception: One and two-family dwellings.

TABLE N1106.1
MINIMUM PIPE INSULATION (INCHES)[a, b]

FLUID DESIGN OPERATING TEMPERATURE RANGE, ºF	INSULATION CONDUCTIVITY		NOMINAL PIPE DIAMETER (IN.)				
	Conductivity range (Btu-in)/(hr.-ft^2-ºF)	Mean rating temperature ºF	1 and less	1 ¼ to 2	2 ½ to 4	5 & 6	6 & up
Heating systems (steam, steam condensate and hot water)[c]							
Above 350	0.32-0.34	250	2.5	3.0	3.0	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 System[d]							
105 and greater	0.24-0.28	100	1[e]	1	1.5	1.5	1.5
Cooling systems (chilled water, brine and refrigerant)							
40-55	0.23-0.27	75	0.5	0.75	1.0	1.0	1.0
Below 40	0.23-0.27	75	1.0	1.5	1.5	1.5	1.5

For **SI**: 1 inch = 25.4 mm. 1 foot = 304.8 mm, ºF = 1.8 ºC + 32

[a] 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,

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K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu-in.[h-ft^2-ºF]) and
K = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

[b] 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.

[c] 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.

[d] Applies to recirculating sections of service or domestic hot water systems and first 8 feet (2.4 mm) from storage tank for noncirculating systems.

[e] Piping less than 1 inch in diameter and less than 12 feet in length shall be insulated with ½ inch insulation with a minimum conductivity of 0.24 Btu-in/hr-ft^2-°F.

N1106.2 Minimum thickness. Insulation thicknesses shall be no less than specified in Table N1106.1. (However, a greater thickness insulation may be required for freeze protection where piping is exposed to subfreezing ambient temperatures.

N1106.3 Water vapor transmission. The minimum insulation thicknesses specified do not consider water vapor transmission and condensation. Additional insulation, vapor retarders, or both, may be required to limit water vapor transmission and condensation.

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

1. Factory-installed piping within HVAC equipment.
2. Piping that conveys fluids that have a design operating temperature range between 55 ºF and 105 ºF (13 ºC and 40.5 ºC).
3. Piping installed in basements, cellars or unventilated crawl spaces with insulated walls.

PART II
ALTERNATIVE SYSTEMS ANALYSIS

SECTION NA1107
ALTERNATIVE SYSTEMS ANALYSIS

This section provides an alternate method of demonstrating code compliance with this chapter by demonstrating that such deviation will result in an annual energy consumption equal to or less than a building that is in compliance with this chapter.

NA1107.1 Equivalent annual energy consumption. The baseline design, conforming to requirements specified in this chapter and the proposed design shall be analyzed using the same procedures. The analyses shall use equal floor area and equal environmental requirements. The comparison shall be expressed in Btu input per gross building square foot of conditioned space per year (MJ/m^2 per year).

NA1107.2 Basis for comparison. Both baseline and proposed alternative designs shall include parameters as specified in Table NA1107.2.

NA1107.2.1 Internal heat gain. The total internal heat gain shall be calculated by Equation NA1107.2.1(1). For single zone calculations, the daily total sensible internal gains (Btu/day) shall be determined by Equation NA1107.2.1(2). For multiple zone HVAC systems, the daily total sensible internal gains (Btu/day) shall be determined by Equation NA1107.2.1(2) for the living zone and Equation NA1107.2.1(3) for the sleeping zone. The daily total latent load for each zone shall be determined using Equation NA1107.2.1(4).

Internal heat gains shall be distributed over the day according to the profile in Table NA1107.2.1(2). The load for each our is the daily total gain multiplied by the factor from the appropriate column.

Where multiple zone space conditioning is modeled, the profile shown for zone 2 shall be used for bedrooms and bathrooms; the profile shown for zone 1 shall be used for all other conditioned rooms. Where single zone space conditioning is modeled, the hourly profile for single-zone designs shall be used.

Equation NA1107.2.1(1)

Total Heat Gains = Sensible Heat Gains + Latent Heat Gains

Equation NA1107.2.1(2)

Single Zone or Living Zone:

Sensible Heat Gains = (Floor Area of Zone X 15 Btu/day · ft^2) + (Number of living units X 20,000 Btu/day)

Equation NA1107.2.1(3)

Sleeping Zone:

Sensible Heat Gains = Floor Area of Zone X 15 Btu/day · ft^2

Equation NA1107.2.1(4)

Latent Heat Gains = 0.2 X Sensible Heat Gains

NA1107.2.2 Thermostat setpoints. In the analysis for both the baseline and proposed designs, all conditioned spaces shall be maintained at the specified thermostat setpoints at all times except for minor deviations at thermostat setback and setup and when outdoor conditions exceed normal design conditions.

If the specified equipment in the proposed design is too small to meet the load, it's capacity shall be increased in the calculations. If equipment to meet a load is not included in the design, such equipment shall be assumed in the calculations and its energy use included. In no case shall the energy use of proposed design be reduced by not conditioning its spaces.

For central space conditioning systems without zonal control, the entire conditioned floor area shall be on

thermostatically controlled zone. The thermostat settings shall be those listed for a single zone in Table NA1107.2.2. For multiple zone designs, the multizone thermostat settings in Table NA1107.2.2 shall be used. Zone 1 represents all conditioned spaces other than zone 2 (bedrooms and bathrooms). The effect of heat transfer between zones including nonclosable openings shall be included in the calculation.

NA1107.3 Analysis procedure. The analysis of the annual energy usage of the standard and the proposed alternative building and system designs shall meet the following criteria:

NA1107.3.1 The building heating/cooling load calculation procedure used for annual energy consumption analysis shall be of sufficient detail to permit the evaluation of effect of building data (such as orientation, size, shape, transfer characteristics of mass, air, moisture, and heat) and hourly climatic data.

NA1107.3.2 The calculation procedure used to simulate the operation of the building and its service systems through a full year operating period shall be of sufficient detail to permit the evaluation of the effect of system design, climatic factors operational characteristics, and mechanical equipment on annual energy usage. Manufacturer's data or comparable field test data shall be used when available in the simulation of all systems and equipment. The calculation procedure shall be based upon 8760 hr of operation of the building and its service systems and shall utilize techniques recommended in the appropriate ASHRAE publications or produce results consistent with such recommended procedures.

NA1107.3.2.1 The calculation procedure shall explicitly cover the following items:

(1) Climatic data: coincident hourly data for temperatures, solar radiation, wind and humidity of typical days in the year representing seasonal variation.

(2) Building data: orientation, size, shape, mass, air, moisture and heat transfer characteristics.

(3) Operational characteristics: temperature, humidity, ventilation, illumination, control mode for occupied and non-occupied hours.

(4) Mechanical equipment: design capacity, part load profile.

(5) Internal heat generation, lighting, equipment, number of people during occupied and non-occupied periods.

TABLE NA1107.2 – BASIS FOR COMPARISON

INPUT PARAMETERS FOR ANALYSIS		
Parameter	**Proposed Building**	**Code Baseline**
Building Envelope		
Opaque Construction Materials	As designed	Code minimum
Fenestration Performance	As designed	Code minimum
Shading devices	As designed	Same as proposed
Window Area	As designed	Same as proposed[a]
Skylight Area	As designed	Same as proposed[b]
Building Orientation	As designed	Same as proposed
Solar Gain	As designed	Same as proposed
Building Infiltration	0.35 ACH Natural	Same as proposed
HVAC Systems		
HVAC System Type(s)	As designed	Same as proposed
HVAC Efficiency	Code efficiencies[c]	Same as proposed[c]
Heating Fuel	As designed	Same as proposed
Cooling Fuel	As designed	Same as proposed
Temperature Setpoints	As designed	Same as proposed
Equipment Capacity	As designed	Same as proposed
Mechanical Ventilation	As designed	Same as proposed
Lighting		
Artificial Lighting	As designed	Same as proposed
Daylighting	As designed	Same as proposed
Design Conditions		
Building Occupancy	As designed	Same as proposed
Building Operational Schedules	As designed	Same as proposed
Climatic Data	As designed	Same as proposed
Internal Loads	As designed	Same as proposed
Cooking Fuel	As designed	Same as proposed

[a] For a single family dwelling unit, detached or attached (rowhouse), only, code baseline window area may be set at 13 percent of heated space floor area when proposed building has less than 13 percent of heated space floor area in windows.

[b] Code baseline skylight area shall be same as proposed up to a maximum of two percent of the heated space floor area

[c] Systems not regulated by code, such as electric heat, shall comply with standard equipment efficiency for such equipment.

NA1107.4 Documentation. Proposed alternative designs, submitted as requests for exception to the standard design criteria, shall be accompanied by an energy analysis comparison report prepared by a registered engineer. The report shall provide sufficient technical detail describing the differences between the two building and systems designs and on the data used in and resulting from the comparative analysis.

NA1107.3.1. The documentation shall demonstrate that the analysis used is consistent with the techniques and procedures specified in this section and the following ASHRAE documents:

(1) 2001 ASHRAE Handbook of Fundamentals

(2) 2000 ASHRAE Handbook of HVAC Systems and Equipment

(3) ASHRAE Principles of Heating, Ventilating and Air Conditioning.

TABLE NA1107.2.2 – THERMOSTAT SETTINGS (ºF)

	Single Zone		Multiple Zone			
			Zone 1 Living		Zone 2 Sleeping	
Time of Day	Heat	Cool	Heat	Cool	Heat	Cool
6 – 9 A.M.	68	78	68	78	68	78
9 A.M. – 5 P.M.	68	78	68	78	60	85
5 – 11 P.M.	68	78	68	78	68	78
11 P.M. – 6 A.M.	60	78	60	85	60	78

PART III
FENESTRATION STANDARD

SECTION NF1108
SCOPE

All windows installed in Oregon shall meet the requirements of this section.

SECTION NF1109
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 NF1111.2 and NF1111.3 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 NF1110
INSULATED GLASS CERTIFICATION

Sealed insulated glass units shall conform to, or be in test for, ASTM E 744–81 as Class A under a Sealed Insulated Glass Manufacturers Association (SIGMA) approved certification program and installed in accordance with the SIGMA glazing specifications.

SECTION NF1111
WINDOW THERMAL PERFORMANCE DESIGNATION FOR NEW 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.

NF1111.1 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. 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.

NF1111.2 Windows products exempt from testing. Thermal performance testing is not required for:

1. Solariums and sunrooms with a minimum of 1/2–inch (12.7 mm) space between the panes.
2. Skylights constituting no more than 10 percent of total glazing in a dwelling.
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 1/2–inch (12.7 mm) space between the panes and low–*e* glass; or triple layered acrylic.
5. Decorative or unique architectural glazing not exceeding one percent of the heated space floor area.

NF1111.3 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 are assigned default *U*–factors prescribed in Section NF1111.4, Item 1.
2. Glazed doors produced in low volume are assigned default *U*–factors prescribed in Section NF1111.4, Item 2.
3. The procedures specified in 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 NF1111.1 for the vertical and overhead glazing contained in solariums.
4. The procedures specified in 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 NF1111.2, Item 2.
5. Skylights specified in Section NF1111.2, Item 3 shall be assigned a default *U*–factor of 0.50.

NF1111.4 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 subsection may validate default *U*–factors by using:

1. Table NF1111.4(1) for windows, or
2. Table NF1111.4(2) for glazed doors, or
3. Table NF1111.4(1) for overhead glazing such as those installed in solariums, or
4. By assuming a *U*–0.50 default for skylights, not exempted by Section NF1111.2, Item 3 when constructed with thermal–break aluminum, or wood, or vinyl frames; with glazing constructed of either a minimum:
   - 4.1. 0.5 inch (12.7 mm) airspace between the glazing with low–*e* and argon gas–filled; or
   - 4.2. of two 0.5 inch (12.7 mm) airspace triple glazing, measured at the center of glazing.

TABLE NF1111.4 (1)
APPROVED WINDOW DEFAULT U-VALUES [a, b]

DESCRIPTION[c, d, e, f, g] (inches)	FRAME TYPE[h]		
	ALUM. THERMAL BREAK[i]	WOOD/VINYL	ALUM CLAD WOOD/ REINFORCED VINYL[j]
Double, Clear ¼	N/A	0.56	0.59
Double, Clear ¼ + argon	0.63	0.53	0.56
Double, Low-*e4* ¼	0.61	0.52	0.54
Double, Low-*e2* ¼	0.58	0.49	0.51
Double, Low-*e1* ¼	0.55	0.47	0.49
Double, Low-*e4* ¼ + argon	0.55	0.47	0.49
Double, Low-*e2* ¼ + argon	0.52	0.43	0.46
Double, Low-*e1* ¼ + 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 ½	0.60	0.50	0.54
Double, Clear ½ + argon	0.58	0.48	0.51
Double, Low-*e4* ½	0.53	0.44	0.47
Double, Low-*e2* ½	0.50	0.41	0.44
Double, Low-*e1* ½	0.47	0.39	0.42
Double, Low-*e4* ½ + argon	0.50	0.42	0.44
Double, Low-*e2* ½ + argon	0.46	0.37	0.40
Double, Low-*e1* ½ + argon	0.43	0.35	0.38
Triple, Clear ¼	0.52	0.42	0.44
Triple, Clear ¼ + argon	0.49	0.39	0.42
Triple, Low-*e4* ¼	0.50	0.40	0.40
Triple, Low-*e2* ¼	0.48	0.39	0.41
Triple, Low-*e1* ¼	0.47	0.38	0.40
Triple, Low-*e4* ¼ + argon	0.46	0.37	0.39
Triple, Low-*e2* ¼ + argon	0.43	0.34	0.37
Triple, Low-*e1* ¼ + argon	0.42	0.34	0.36
Triple, Clear ½	0.46	0.37	0.40
Triple, Clear ½ + argon	0.45	0.36	0.38
Triple, Low-*e4* ½	0.43	0.35	0.37
Triple, Low-*e2* ½	0.41	0.32	0.35
Triple, Low-*e1* ½	0.39	0.31	0.33
Triple, Low-*e4* ½ + argon	0.41	0.32	0.35
Triple, Low-*e2* ½ + argon	0.38	030	0.32
Triple, Low-*e1* ½ + argon	0.37	0.29	0.31

For **SI:** 1 inch = 25.4 mm.

[a] Subtract 0.02 from the listed default *U*-value for insulated spacers. Insulated spacer material includes fiberglass, wood and butyl or other material with an equivalent *K*-value.

[b] Solariums may subtract 0.03 from the default *U*-value.

[c] ¼" = a minimum dead air space of 0.25 inch between the panes of glass.
$^3/_8$" = a minimum dead air space of 0.375 inch between the panes of glass.
½" = a minimum dead air space of 0.5 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. ¾"-inch = ½"-inch *U*-values, $^7/_{16}$-inch = $^3/_8$-inch *U*-values, $^5/_{16}$-inch = ¼" *U*-values.

[d] 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.

[e] *U*-values listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO_2, SF_6 and argon/SF_6 mixtures.
The following conversion factor shall apply to Krypton gas-filled units:
¼"-inch or greater airspace with Krypton gas fill = ½-inch airspace with Argon gas-fill.

[f] Dividers placed between glazing: The *U*-values 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*-value for True Divided Lite windows.

[g] "Glass block" assemblies may use a *U*-value of 0.51.

[h] Insulated fiberglass framed products shall use wood/vinyl *U*-values.

[i] Alum. Thermal Break = An aluminum thermal break framed window shall incorporate the following minimum design characteristics:
1) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/hr/ft^2/ºF;
2) The thermal break material shall not be less than 0.210 inch; and
3) All metal framing members of the product to interior and exterior air must incorporate a thermal break meeting the criteria in 1) and 2) above.

[j] Aluminum clad wood windows shall use the *U*-values listed for Alum. Clad Wood/Reinforced Vinyl windows. Vinyl clad windows shall use the *U*-values listed for Wood/Vinyl windows. Any vinyl frame window with metal reinforcement in more than one rail shall use the *U*-values listed for Alum. Clad Wood Reinforced Vinyl windows.

TABLE NF1111.4 (2)
APPROVED GLAZED DOOR DEFAULT U-VALUES[a]

DESCRIPTION[b, c, d, e] (inches)	DOOR MATERIAL			
	INSULATED[f]		WOOD[g]	
	Full-Lite[h, i]	Half-Lite[j, k]	Full-Lite[h]	Half-Lite[j]
Double, Clear ¼	0.39	0.31	0.47	0.42
Double, Clear ¼ + argon	0.37	0.30	0.45	0.41
Double, Low-*e4* ¼	0.36	0.30	0.44	0.41
Double, Low-*e2* ¼	0.35	0.29	0.43	0.40
Double, Low-*e1* ¼	0.24	0.28	0.41	0.39
Double, Low-*e4* ¼ + argon	0.33	0.28	0.41	0.39
Double, Low-*e2* ¼ + argon	0.31	0.26	0.39	0.38
Double, Low-*e1* ¼ + 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 ½	0.36	0.29	0.44	0.41
Double, Clear ½ + argon	0.34	0.28	0.42	0.40
Double, Low-*e4* ½	0.32	0.27	0.40	0.38
Double, Low-*e2* ½	0.30	0.26	0.38	0.37
Double, Low-*e1* ½	0.19	0.25	0.36	0.36
Double, Low-*e4* ½ + argon	0.30	0.26	0.38	0.37
Double, Low-*e2* ½ + argon	0.28	0.25	0.36	0.36
Double, Low-*e1* ½ + argon	0.28	0.24	0.34	0.35
Triple, Clear ¼	0.31	0.26	0.39	0.38
Triple, Clear ¼ + argon	0.29	0.25	0.37	0.37
Triple, Low-*e4* ¼	0.30	0.26	0.38	0.37
Triple, Low-*e2* ¼	0.29	0.25	0.37	0.36
Triple, Low-*e4* ¼ + argon	0.27	0.24	0.35	0.35
Triple, Low-*e2* ¼ + argon	0.26	0.24	0.34	0.35

For **SI:** I inch = 25.4 mm.

[a] Subtract 0.02 from the listed default *U*-value for insulated spacers. Insulated spacer material includes fiberglass, wood and butyl or other material with an equivalent *K*-value.

[b] ¼" = a minimum dead air space of 0.25 inch between the panes of glass.
$^3/_8$" = a minimum dead air space of 0.375 inch between the panes of glass.
½" = a minimum dead air space of 0.5 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. ¾"-inch = ½"-inch *U*-values, $^7/_{16}$-inch = $^3/_8$-inch *U*-values, $^5/_{16}$-inch = ¼" *U*-values.

[c] 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.

[d] *U*-values listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO_2, SF_6 and argon/SF_6 mixtures.
The following conversion factor shall apply to Krypton gas-filled units:
¼"-inch or greater airspace with Krypton gas fill = ½-inch airspace with Argon gas-fill.

[e] Dividers placed between glazing: The *U*-values 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*-value for True Divided Lite windows.

[f] Insulated = Any urethane insulated foam core door with a thermal break. Thermal Break = A thermal break door shall incorporate the following minimum design characteristics:
1) The thermal conductivity of the thermal break material shall be not more than 3.6 Btu-in/hr/ft^2/^{o}F; and
2) The thermal break material shall not be less than 0.210 inch.

[g] Wood = Any wood door.

[h] Full Lite = A door that consists of more than 35 percent glazing.

[i] Add 0.05 to the listed *U*-value for Full-Lite values if insulated door does not have a thermal break.

[j] Half Lite = A door that consists of 35 percent or less glazing.

[k] Add 0.06 to the listed *U*-value for Half-Lite values if the insulated door does not have a thermal break.

SECTION NF1112
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.

NF1112.1 Labeling. Labeling is not required for decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area and is exempt from Table N1104.1(2) thermal performance calculations.

NF1112.2. Except as provided in Section NF1112.1, all windows shall have labeling that is:

1. Imprinted, not handwritten;
2. Facing the interior of the room; and
3. Attached to the window until the building inspector inspects and verifies the labeling; and

NF1112.3. Manufactured window labels shall also list the *U*–factor or *U*–factor Class.

NF1112.4 Skylights exempt from thermal performance standards. Labels for skylights exempted from thermal performance standards under Section NF1111.2, 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 (19.1 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."

NF1112.5 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 NF1111.2, Items 1, 2 and 4 shall:

1. Specify the window components and configuration; and
2. Show the U–value determined by Section NF1111.3, Item 3.

Exception: Exempt solariums and skylights may be labeled as certified through the NFRC procedure as specified in Section NF1111.1.

NF1112.6 Windows produced in low volume or site–built. Labeling and disclosure shall comply with the following sub-sections:

NF1112.6.1 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 NF1109 Item 1; and
4. Imprint "(*Manufacturer's name*) certifies the attached window is constructed in a manner to obtain the specified *U*–factor."

NF1112.6.2 Labels for skylights produced in low volume, when constructed with thermal–break aluminum, or 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 N1102, Item 1; and
5. *Imprint* "(*Manufacturer's name*) certifies the attached skylight complies with the criteria specified in the Oregon building codes."

NF1112.6.3 Labels for skylights produced in low volume, not meeting the construction and configuration requirements of Section NF1112.6.2 and not otherwise exempt under Section NF1111.2, Item 4 shall:

1. Specify window components;
2. State "Calculated *U*–factor Skylight Compliance Label";
3. Show the *U*–factor determined by Section NF1111.3, Item 4; and
4. Show a production count number that does not exceed the maximums established in Section NF1109, Item 1.

NF1112.6.4 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 NF1109 Item 1;
3. Show the *U*–factor determined by Sections NF1111.4 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*–factors"; and
5. Have one label providing a description of each of the glazed surfaces.

Exception: Products specified in Sections NF1112.6.1, NF1112.6.2 and NF1112.6.3, may be labeled as certified through the NFRC procedure as specified in Section NF1111.1.

NF1112.7 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.

NF1112.8 Label distribution. Labels under Sections NF1111.2 through NF1111.4 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 NF1113
AIR LEAKAGE REQUIREMENTS

Windows shall comply with the air leakage requirements of Section N1104.7.

Exception: Site-built windows.

SECTION NF1114
ALTERATIONS

New windows shall have maximum *U*-factor of 0.40. Windows shall be tested and labeled in accordance with Sections N1104 and N1105.

Exceptions: 1. Skylights allowed under Section NF1111.2, Item 4.

2. Decorative or unique architectural feature glazing not exceeding 1 percent of the heated space floor area may be exempt from thermal performance testing and labeling, and Table N1101.1(2) calculations.

3. Where necessary to retain architectural consistency with remaining windows in the building, new windows shall have a maximum U-value of 0.65.