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CHAPTER

11

ENERGY EFFICIENCY

PART I—ENERGY CONSERVATION

SECTION N1101—SCOPE

N1101.1 General. The provisions of this chapter regulate the exterior envelope, as well as the design, construction and selection of *heating, ventilating and air-conditioning systems*, piping insulation, lighting and power required for the purpose of effective conservation of energy within a building or structure governed by this code. Residential buildings shall comply with Section N1101.1.1, N1101.1.2, or N1101.1.3.

Exceptions:

1. Application for existing buildings shall comply with Section N1101.2.
2. Application for additions shall comply with Section N1101.4.

N1101.1.1 Prescriptive compliance option. The prescriptive compliance option requires compliance with Sections N1103 through N1108.

All *conditioned spaces* within residential buildings shall comply with Table N1101.1(1) and ~~one~~ two additional measures from Table N1101.1(2). New buildings using Section N1105.3, Exception 3, shall comply with ~~two~~ three additional measures from Table N1101.1(2) and sealing requirements in accordance Sections N1104.8.2 and N1105.3.1.

Exceptions:

1. Application to *small homes* shall comply with Table N1101.1(1) and one additional measure from Table N1101.1(2). *Small homes* using Section N1105.3, Exception 3, shall comply with two additional measures from Table N1101.1(2) and the sealing requirements in Sections N1104.8.2 and N1105.3.1.
2. Heated or cooled detached *accessory structures* ~~that are not habitable~~ shall meet the following envelope requirements without any additional measures: (walls: R-21/~~U-0.064~~ U-0.063; heated slab interior: R-10 under entire slab and R-15 slab edge; underfloors: R-30; roofs: ~~R-38~~ R-49/~~U-0.027~~ U-0.021 (*attic*) or R-20 *continuous insulation*/U-0.048 (above deck); windows and glazed doors: ~~U-0.35~~ U-0.30; opaque doors: ~~U-0.70~~ U-0.20; roll-up doors: U-0.50).

N1101.1.2 Energy rating index option. The Energy Rating Index (ERI) Option requires compliance with Section N1109.

N1101.1.3 Total simulated building performance option. The Total simulated building performance option requires compliance with Section N1110.

TABLE N1101.1(1)—PRESCRIPTIVE ENVELOPE REQUIREMENTS^a

BUILDING COMPONENT	STANDARD <u>REFERENCE DESIGN</u>		LOG HOMES ONLY	
	Required Performance	Equivalent Value ^b	Required Performance	Equivalent Value ^b
Wall insulation—above grade	U-0.059 ^c	R-21 Intermediate ^c	Note d	Note d
Wall insulation—below grade ^e	C-0.063	R-15 c.i./R-21	C-0.063	R-15/R-21
Flat ceilings ^f	U-0.021	R-49	U-0.020	R-49 A ^h
Vaulted ceilings ^g	U-0.033	R-30 Rafter or R-30A ^{g, h} Scissor Truss	U-0.027	R-38A ^h
Underfloors	U-0.033	R-30	U-0.033	R-30
Slab-edge perimeter ^l	F-0.520	R-15	F-0.520	R-15
Heated slab interior ^l	N/A	R-10	N/A	R-10
Windows <u>and glazed doors</u> ^j	U-0.27	U-0.27	U-0.27	U-0.27
Skylights	U-0.50	U-0.50	U-0.50	U-0.50
Exterior doors ^k	U-0.20	U-0.20	U-0.54	U-0.54

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m², 1 degree = 0.0175 rad, N/A = Not Applicable.

- a. As allowed in 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-factor standards. Calculations to document equivalent heat loss shall be performed using the procedure and approved U-factors contained in Table N1104.1(1).
- b. R-values used in this table are nominal for the insulation only in standard wood-framed construction and not for the entire assembly.
- c. 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. Nominal compliance with R-21 insulation and Intermediate Framing (Section N1104.5.2) with insulated headers.
- d. The wall component shall be a minimum solid log or timber wall thickness of 3 1/2 inches.
- e. Below-grade wood, concrete or masonry walls include all walls that are below grade and do not include those portions of such wall that extend more than 24 inches above grade. R-21 for insulation in framed cavity; R-15 continuous insulation.
- f. 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. Where reduced, the cavity shall be filled (except for required ventilation spaces). ~~R-49 insulation installed to minimum 6-inch depth at top plate at exterior of structure to achieve U-factor.~~

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TABLE N1101.1(1)—PRESCRIPTIVE ENVELOPE REQUIREMENTS^a—continued

<ul style="list-style-type: none"> g. Vaulted ceiling heated space floor area exceeding 50 percent of the total heated space floor area shall have a <i>U</i>-factor not greater than U-0.026 (equivalent to R-38 rafter or scissor truss with R-38 advanced framing). h. A = Advanced frame construction. See Section N1104.6. i. Heated slab interior applies to concrete slab floors (both on and below grade) that incorporate a radiant heating system within the slab. Insulation shall be installed underneath the entire slab in addition to perimeter insulation. j. Glass doors shall comply with window performance requirements. Windows exempt from testing in accordance with Section N1104.4 shall comply with window performance requirements if constructed with aluminum with thermal break, wood, vinyl, reinforced vinyl aluminum-clad wood, or insulated fiberglass frames, and double-pane glazing with low-emissivity coatings of 0.10 or less. Buildings designed to incorporate passive solar elements may include glazing with a <i>U</i>-factor greater than 0.35 by using Table N1104.1(1) to demonstrate equivalence to building envelope requirements. k. A maximum of 28 square feet of exterior door area per dwelling unit can have a <i>U</i>-factor of 0.54 or less. l. Minimum 24-inch horizontal or vertical below grade. The minimum total distance of 24 inches may be a combination of the horizontal and vertical planes. If a horizontal plane is used on the exterior of the slab, it must be a minimum of 12 inches below finished grade.

TABLE N1101.1(2)—ADDITIONAL MEASURES

MEASURE NUMBER	MEASURE DESCRIPTION
1	HIGH-EFFICIENCY HVAC SYSTEM^a <ul style="list-style-type: none"> a. Gas-fired furnace or boiler AFUE 94<u>95</u> percent, or b. Air source heat pump HSPF 10.0/16.0 SEER cooling or 8.5 HSPF2 / 15.0 SEER2, or c. Ground-source heat pump COP 3.5 or ENERGY STAR rated
2	HIGH-EFFICIENCY WATER HEATING SYSTEM <ul style="list-style-type: none"> a. Natural gas/propane water heater with minimum 0.90 UEF, or b. Electric heat pump water heater with minimum 3.45 UEF, or c. Natural gas/propane tankless/instantaneous heater with minimum 0.80 UEF and drain water heat recovery unit installed on a minimum of one shower/tub-shower
3	WALL INSULATION UPGRADE Exterior walls—U-0.045/R-21 conventional framing with R-5.0 continuous insulation
4	ADVANCED ENVELOPE Windows—U-0.21 (Area-weighted average), and Flat ceiling ^b —U-0.017/R-60, and Framed floors—U-0.026/R-38 or slab edge insulation to F-0.48 or less (R-10 for 48"; R-15 for 36" or R-5 fully insulated slab)
5	DUCTLESS HEAT PUMP (Dwelling units with all-electric heat) <ul style="list-style-type: none"> a. Provide ductless heat pump of minimum HSPF 10.0 or HSPF2 9.0 in primary zone replaces zonal electric heat sources, and b. Provide programmable thermostat for all heaters in bedrooms
6	HIGH-EFFICIENCY THERMAL ENVELOPE UA^c <u>In accordance with Table N1104.1(1), the total Proposed UA of the Proposed Design shall be a minimum 10 percent less than the total standard reference design UA of the standard reference design. Proposed UA is 8 percent lower than the code UA.</u>
7	2.75 ACH AIR LEAKAGE CONTROL AND EFFICIENT VENTILATION Achieve a maximum of 2.75 ACH50 whole-house air leakage when third-party tested and provide a whole-house ventilation system, including heat recovery with a minimum sensible heat recovery efficiency of not less than 66 percent and total fan efficacy of 1.6 CFM/Watt (combined input for supply and exhaust).
8	<u>RENEWABLE ENERGY.^d</u> <u>Install a minimum 4.0 kWh or 1.5 W/SF of on-site renewable energy, whichever is greater.</u>
For SI: 1 square foot = 0.093 m ² , 1 watt per square foot = 10.8 W/m ² .	
<ul style="list-style-type: none"> a. Appliances located within the building thermal envelope shall have sealed combustion air installed. Combustion air shall be ducted directly from the outdoors. b. The maximum vaulted ceiling surface area shall not be greater than 50 percent of the total heated space floor area unless vaulted area has a <i>U</i>-factor not greater than U-0.026. c. In accordance with Table N1104.1(1), the Proposed UA total of the Proposed Alternative Design shall be a minimum 8 percent less than the Code UA total of the Standard Base Case. Additional Measure Number 6 is not permitted to be combined with Additional Measure Number 3 or 4. d. <u>Additional kW shall not equate to an additional measure.</u> 	

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N1101.2 Application to existing buildings. *Alterations 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.*

TABLE N1101.2—EXISTING BUILDING COMPONENT REQUIREMENTS		
BUILDING COMPONENTS	REQUIRED PERFORMANCE	EQUIVALENT VALUE
Wall insulation	U-0.083	R-15
Flat ceiling	U-0.025 <u>U-0.021</u>	R-49
Vaulted ceiling >10 inches nominal rafter depth	U-0.040 <u>U-0.033</u>	R-25 <u>R-30</u>
Vaulted ceiling ≤10 inches nominal rafter depth	U-0.047 <u>U-0.040</u>	R-21 <u>R-24</u>
Underfloor > 10 inches nominal joist depth	U-0.028 <u>U-0.027</u>	R-30 <u>R-38</u>
Underfloor ≤10 inches nominal joist depth	U-0.039 <u>U-0.033</u>	R-25 <u>R-30</u>
Slab-edge perimeter	N/A	N/A
<u>Heated Slab</u>	<u>N/A</u>	<u>R-10</u>
Windows and glazed doors	U-0.30	U-0.30
Skylights	U-0.50	U-0.50
Exterior doors	U-0.20	R-5

For SI: Inch = 25.4 mm, 1 square foot = 0.0929 m². N/A = Not Applicable.

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

Where *alterations or repairs* affect components of existing *conditioned spaces* regulated in this chapter, those components shall comply with this chapter.

Exception: The minimum existing component requirements as specified in Table N1101.2 shall be used to the maximum extent technically practical due to existing constraints, which may include but are not limited to the available cavity depth, matching existing features and similar constraints.

N1101.2.2 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.

N1101.2.3 Change of occupancy or use. Definition of “change of use” for purposes of Section N1101.2.3.1 is a change of use in an existing *residential building* and shall include any of the following: any unconditioned spaces such as an attached garage, *basement*, porch, *attic*, or canopy that are to become *conditioned spaces*.

N1101.2.3.1 Change of use. A building that changes use, without any changes to the components regulated in this chapter, is required to comply with Table N1101.2 to the greatest extent practical. Changes of use that are greater than 30 percent of the existing building heated floor area or more than 400 square feet (37 m²) in area, whichever is less, shall be required to comply with one measure from Table N1101.3.2.

N1101.2.3.2 Change of occupancy. *Alteration and repair* of conditioned nonresidential buildings, such as a *change of occupancy* from a small church or school to a residential dwelling shall use Table N1101.2 to the greatest extent practical and comply with one measure from Table N1101.1(2) or Table N1101.3.2.

Exception: The minimum component requirements shall be disregarded where thermal performance calculations are completed for change of use to a Group R-3 occupancy, and such calculations demonstrate similar performance to the requirements of Table N1101.2.

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.

N1101.3.1 Large additions. *Additions* that are equal to or more than 600 square feet (56 m²) in area shall be required to comply with one measure from Table N1101.1(2).

N1101.3.2 Small additions. *Additions* that are less than 600 square feet (56 m²) in area shall comply with one measure from Table N1101.1(2) or Table N1101.3.2.

Exception: *Additions* that are less than 225 square feet (20.9 m²) in area shall not be required to comply with Table N1101.1(2) or Table N1101.3.2.

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TABLE N1101.3.2—SMALL ADDITION ADDITIONAL MEASURES (select one)	
MEASURE NUMBER	MEASURE DESCRIPTION
1	Increase the ceiling insulation of the existing portion of the home as specified in Table N1101.2.
2	Replace all existing single-pane wood or aluminum windows to the <i>U</i> -factor as specified in Table N1101.2
3	Insulate the existing floor, crawl space or basement wall systems as specified in Table N1101.2 and install 100 percent of permanently installed lighting fixtures as CFL, LED or linear fluorescent, or a minimum efficacy of 40 lumens per watt as specified in Section N1107.2.
4	Test the entire dwelling with a blower door and exhibit not more than 4.5 air changes per hour @ 50 Pascals.
5	Seal and performance test the duct system <u>to not greater than 4.5 cubic feet per minute per 100 square feet of conditioned floor area.</u>
6	Replace existing 80-percent AFUE or less gas furnace with a 94 95-percent AFUE or greater system.
7	Replace existing electric radiant space heaters with a ductless mini split system with a minimum HSPF of 10.0 or HSPF2 of 9.0.
8	Replace existing electric forced-air furnace with an air source heat pump with a minimum HSPF of 9.5 or HSPF2 of 8.1.
9	Replace existing water heater with one of the following: a. Natural gas/propane water heater with minimum UEF 0.90, or b. Electric heat pump water heater with minimum 3.45 UEF.

For SI: 1 cubic foot per minute per square foot = 0.0033 LPM/m², 1 cfm = 28.3 LPM.

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, *fenestration U*-factors, HVAC equipment efficiency performance and system controls, ductwork location, lighting, the additional measure(s) from Table N1101.1(2), and the other pertinent data to indicate compliance with the requirements of the chapter.

N1101.5 Certificate. A permanent certificate shall be completed by the builder or other approved party and posted on a wall in the space where the furnace is located or an approved location inside the building. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall indicate the following:

1. The code edition under which the structure was permitted, the compliance path used, and the additional efficiency measures selected from Table N1101.1 as applicable.
2. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, basement walls, crawl space walls and floors, and ducts outside conditioned spaces.
3. *U*-factors of fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for any component of the building thermal envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency is not required to be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.
5. The results from any required duct system and building thermal envelope air leakage testing performed on the building.
6. Where on-site photovoltaic panel systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.
7. The location and dimensions of the solar-ready zone where one is provided per Section R324.7.2.
8. For buildings where an Energy Rating Index (ERI) score is determined in accordance with Section N1109, the ERI score, both with and without on-site generation, shall be listed.
9. For buildings where the simulated building performance is utilized in accordance with Section N1110, comply with N1110.5.4.1 and N1110.5.4.2.

SECTION N1102—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 US DOE 10 CFR, Part 430, *Test Procedures*.

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 "*Manual*.")

BASEMENT WALL. The opaque portion of any wall which encloses a *basement* and is partially or totally below grade.

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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 finished 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 59°F to 60°F (15°C to 16°C).

BUILDING THERMAL ENVELOPE. That element of a building that 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*.”

CLEAR HEADROOM. The distance from the top of the bottom chord of the truss or ceiling joists to the underside of the roof sheathing.

CONDITIONED SPACE. A space within the building, separated from unconditioned space by the *building thermal envelope*, 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 55°F (13°C) or higher for heating and/or 85°F (29.4°C) 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 *conditioned space*.)

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

ENERGY COST. The total estimated annual cost for purchased energy for the building functions regulated by this code, including applicable demand charges.

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 thermal envelope*.”

EXTERIOR WALL. Any member, or group of members, that defines the exterior boundaries of the *conditioned space*, and which has a slope of 60 degrees (1.05 rad) 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 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, 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 exterior *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. 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. 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.

HIGH-EFFICIENCY LIGHT SOURCE. Compact fluorescent lamps, T-8 or smaller diameter linear fluorescent lamps, LED lamps, fixture-integrated illumination devices, or lamps with an efficacy not less than 65 lumens per watt for each lamp or luminaires with an efficacy not less than 45 lumens per watt for each luminaire.

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 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*”).

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

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 [grain/h-ft²-in Hg (0°C)]. Permeance may be measured by using ASTM E96 or other *approved* dry cup method. The closer the dry cup perm rating approaches zero, the better the vapor retarder. Permeability is defined as the permeance of a material for specified unit length (perm/in).

PROPOSED DESIGN. A description of the proposed dwelling unit used to estimate annual energy use for determining compliance based on simulated building performance.

R (THERMAL RESISTANCE). See “*Thermal resistance.*”

R_t (THERMAL RESISTANCE TOTAL). See “*Thermal resistance total.*”

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

SIMULATED BUILDING PERFORMANCE. A process in which the propose building design is compared to a standard reference design for the purposes of estimating relative energy use to determine code compliance.

SMALL HOME. A dwelling with less than 1,350 square feet (125 m²) of conditioned living area.

STANDARD REFERENCE DESIGN (SRD). A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total simulated building performance.

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/h × ft² × °F) [W/(m² × K)]. It is the reciprocal of thermal resistance (see “*Thermal resistance*”).

THERMAL CONDUCTIVITY (K). The rate of heat flow through 1 square foot (0.0929 m²) of a homogeneous material 1 inch (25.4 mm) in thickness when there is a temperature difference of 1°F (0.56°C) between the opposite faces of the material, expressed as Btu/h per square foot per °F 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 (h × ft² × °F/Btu) [(m² × K)/W] and is the reciprocal of thermal conductance.

THERMAL RESISTANCE TOTAL (R_t). The sum of the resistance for all of the individual components of the assembly, including framing members, multiple layer connections, insulation and air films expressed in (Btu/h × ft² × °F) [W/(m² × K)].

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/h × ft² × °F).

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

U-FACTOR (THERMAL TRANSMITTANCE). See “*Thermal transmittance.*”

VAULTED CEILING. ~~A ceiling with a minimum slope of 2 in 12.~~ A ceiling that extends above the typical ceiling height into an unused volume via a self-supporting arch. Also includes “cathedral ceilings.”

WINDOW. See “*Exterior window.*”

WINDOWS PRODUCED IN LOW VOLUME. See Section N1112.1.

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 N1103—ALTERNATIVE SYSTEMS

Alternative designs may be approved by the building official when it can be demonstrated that the proposed building complies with Part II, Alternative Systems Analysis, of this chapter.

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*.

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SECTION N1104—EXTERIOR ENVELOPE REQUIREMENTS

N1104.1 General. This section provides minimum requirements for exterior envelope construction.

The *exterior building envelope* shall comply with Table N1101.1(1) or shall be demonstrated using Table N1104.1(1). The requirements specified in Table N1101.1(2) shall apply to both Tables N1101.1(1) and N1104.1(1).

Buildings designed to incorporate passive solar elements may use Table N1104.1(1) to demonstrate *building thermal envelope* requirements in this code, in addition to requirements specified in Table N1101.1(2).

TABLE N1104.1(1)—RESIDENTIAL THERMAL PERFORMANCE CALCULATIONS

BUILDING COMPONENTS ^b	REFERENCE DESIGN CASE ^a			PROPOSED A		ALTERNATIVE	
	Areas ^c	U-factor	Areas × U	R-value ^d	Areas ^c	U-factor ^e	Areas × U
Flat ceilings		0.021					
Vaulted ceilings ^f		0.033					
Conventional wood-framed walls		0.059					
Underfloor		0.033					
Slab-edge		F = 0.52 ^g					
Below-grade walls		C = 0.063 ^g					
Windows		0.27					
Skylights		0.50					
Exterior doors ^h		0.2					
Code UA =				Proposed UA ⁱ =			
<p>For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m², 1 degree = 0.0175 rad, N/A = Not Applicable.</p> <p>a. Base path 1 represents standard <u>reference design</u> from Table N1101.1(1). U-factors shall be adjusted to match Table N1101.1(2) for compliance with Additional Measure Number 4, if selected.</p> <p>b. Performance trade-offs are limited to those listed in Column 1. Heat plant efficiency, duct insulation levels, passive and active solar heating, air infiltration and similar measures, including those not regulated by this code must not be considered in this method of calculation.</p> <p>c. Areas from plan take-offs. All areas must be the same for both standard <u>reference design</u> and Proposed Alternate. The vaulted ceiling surface area for standard <u>reference design</u> must be the actual surface area from the plan take-off not to exceed 50 percent of the total heated space floor area. Any roof areas in excess of 50 percent for <u>reference design</u> must be entered at U-0.021 (R-49) with “Flat ceilings” area.</p> <p>d. Minimum component requirements insofar as practicable: above-grade walls R-15/U-0.080<u>U-0.083</u>; underfloors R-21/U-0.047; flat ceilings R-38/U-0.031; vaulted ceilings R-21/U-0.055; below-grade wood, concrete or masonry walls R-15/C-0.069; slab edge R-10/F-0.52. 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 <u>U-0.65</u> (CL65). A single door not to exceed 28 square feet per dwelling unit is permitted to be excluded from the thermal performance calculations. All other door-values shall not exceed 0.54 (Nominal R-2).</p> <p>e. U-factors for wood-framed ceilings, walls and floor assemblies shall be as specified in Table N1104.1(2). U-factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using ASHRAE <i>Handbook of Fundamentals</i> procedures.</p> <p>f. Vaulted area, unless insulated to R-38, U-0.026, shall not exceed 50 percent of the total heated space floor area.</p> <p>g. F = the heat loss coefficient, Btu/ h × ft² ×°F per foot of perimeter. C = the heat loss coefficient Btu/ h × ft² ×°F per square foot of underground wall.</p> <p>h. A maximum of 28 square feet of exterior door area per dwelling unit can have a U-factor of 0.54 or less. Default U-factor for an unglazed wood door is 0.54.</p> <p>i. Proposed UA must be less than or equal to Code UA. For compliance with Table N1101.1(2), Additional Measure Number 6, the Proposed UA must be a minimum 8 percent less than the Code UA.</p>							

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TABLE N1104.1(2)—APPROVED DEFAULT U-FACTORS

FLAT CEILINGS ^a			EXTERIOR WALLS ^a			
Insulation	Type	U-Factor	Insulation	Insulation Sheathing	Framing	U-Factor
R-38	Conventional framing	0.027	R-15	0	Conventional framing	0.083
R-38	Advanced framing ^c	0.026	R-15	0	Intermediate framing ^b	0.078
R-49	Conventional framing	0.021	R-19	0	Conventional framing	0.067
R-49	Advanced framing ^c	0.020	R-19	0	Intermediate framing ^b	0.063
R-60	Conventional framing	0.017	R-19	0	Advanced framing ^d	0.062
R-60	Advanced framing ^c	0.016				
VAULTED CEILINGS ^a			R-21	0	Conventional framing	0.063
Insulation	Type	U-Factor	R-21	0	Intermediate framing ^b	0.059
R-21	Rafter framings	0.050	R-21	0	Advanced framing ^d	0.057
R-30	Rafter framing	0.032	R-23	0	Conventional framing	0.059
R-38	Rafter framing	0.026	R-23	0	Intermediate framing	0.055
R-21	Scissors truss	0.052	R-23	0	Advanced framing ^d	0.053
R-30	Scissors truss	0.034	R-13	3.5 ^e	Conventional framing	0.065
R-38	Scissors truss	0.027	R-13	5 ^e	Conventional framing	0.059
R-49	Scissors truss	0.021	R-13	7 ^e	Conventional framing	0.053
R-30	Advanced scissors truss ^c	0.032	R-13	3.5 ^e	Advanced framing ^d	0.062
R-38	Advanced scissors truss ^c	0.026	R-13	5 ^e	Advanced framing ^d	0.056
R-49	Advanced scissors truss ^c	0.020	R-13	7 ^e	Advanced framing ^d	0.050
EPS FOAM CORE PANEL VAULTED CEILINGS			R-15	3.5 ^e	Conventional framing	0.062
Insulation	Type	U-Factor	R-15	5 ^e	Conventional framing	0.056
R-29	8 1/4" EPS foam core panel	0.034	R-15	7 ^e	Conventional framing	0.050
R-37	10 1/4" EPS foam core panel	0.027	R-15	3.5 ^e	Advanced framing ^d	0.057
R-44	12 1/4" EPS foam core panel	0.023	R-15	5 ^e	Advanced framing ^d	0.052
			R-15	7 ^e	Advanced framing ^d	0.047
FLOORS ^a			R-19	3.5 ^e	Conventional framing	0.052
Insulation	Type	U-Factor	R-19	5 ^e	Conventional framing	0.048
R-21	Underfloor	0.046	R-19	7 ^e	Conventional framing	0.044
R-25	Underfloor	0.039	R-19	3.5 ^e	Intermediate framing ^b	0.050
R-30	Underfloor	0.033	R-19	5 ^e	Intermediate framing ^b	0.047
R-38	Underfloor	0.026	R-19	7 ^e	Intermediate framing ^b	0.043
R-49	Underfloor	0.020	R-19	3.5 ^e	Advanced framing ^d	0.049
SLAB-ON-GRADE			R-19	5 ^e	Advanced framing ^d	0.046
Insulation	Type	F-Factor ^f	R-19	7 ^e	Advanced framing ^d	0.042
R-10	Slab edge 24"	0.54	R-21	3.5 ^e	Conventional framing	0.049
R-15	Slab edge 24"	0.52	R-21	5 ^e	Conventional framing	0.045
R-20	Slab edge 24"	0.51	R-21	3.5 ^e	Intermediate framing ^b	0.047
R-5	Slab edge 48"	0.48	R-21	5 ^e	Intermediate framing ^b	0.044
R-15	Slab edge 48"	0.45	R-21	7 ^e	Intermediate framing ^b	0.040
R-20	Slab edge 48"	0.43	R-21	3.5 ^e	Advanced framing ^d	0.046
R-5	Under slab continuous	0.46	R-21	5 ^e	Advanced framing ^d	0.043
R-7.5	Under slab continuous	0.41	R-21	7 ^e	Advanced framing ^d	0.039
R-10	Under slab continuous	0.36	R-21	3.5 ^e	Advanced framing ^d	0.046
EPS FOAM CORE PANEL EXTERIOR WALLS						
Insulation	Type	U-Factor	R-23	3.5 ^e	Conventional framing	0.046
R-14.88	4 1/2" EPS foam core panel	0.059	R-23	5 ^e	Conventional framing	0.042
R-22.58	6 1/4" EPS foam core panel	0.040	R-23	7 ^e	Conventional framing	0.038
R-29.31	8 1/4" EPS foam core panel	0.031	R-23	3.5 ^e	Advanced framing ^d	0.043
			R-23	5 ^e	Advanced framing ^d	0.040
BELOW GRADE WALLS			R-23	7 ^e	Advanced framing ^d	0.036
Insulation	Type	C-Factor				
R-10 c.i.	R-10 continuous insulation	0.085				
R-15 c.i.	R-15 continuous insulation	0.063				
R-13	R-13 cavity and air space	0.080				
R-21	R-21 cavity and air space	0.063				

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TABLE N1104.1(2)—APPROVED DEFAULT U-FACTORS—continued

For SI: 1 inch = 25.4 mm.

- a. *U*-factors are for wood-framed construction. *U*-factors for other assemblies, which include steel framing, brick or other masonry, stucco, etc., shall be calculated using standard ASHRAE *Handbook of Fundamentals* procedures or ASHRAE 90.1 Appendix A.
- b. Intermediate framing consists of wall studs placed at a minimum 16 inches on center with insulated headers. Voids in headers 1 inch to 2 inches in thickness shall be insulated with rigid insulation having a minimum *R*-value of 4 per 1-inch thickness. Voids in headers greater than 2 inches in depth shall be insulated to a minimum level of *R*-10.
- c. Advanced framing construction for ceilings as defined in Section N1104.6.
- d. Advanced framing construction for walls as defined in Section N1104.5.1
- 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/ h × ft² × °F per lineal foot of concrete slab perimeter for 24 inches below grade.

N1104.2 Insulation materials. Insulation materials shall be installed in accordance with manufacturer's listing and installation instructions and this code. Insulation *R*-values shall be specified as required in Part 460 of US-FTC CFR Title 16. Cellulose insulation shall conform to CPSC 16 CFR, Part 1209. Foam plastic shall be as specified in Section R316.

N1104.2.1 Insulation clearance restriction. Blown, poured, batt and spray-on type insulation applied from above the ceiling level shall be limited to vented 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 clear 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.)~~ Netted or other applications that allow for verification of insulation application shall be allowed for low-slope roofs.

N1104.2.2 Depth markers. The thickness of blown-in or sprayed fiberglass and cellulose roof and ceiling insulation shall be written in inches (mm) on markers that are installed at not less than one for every 300 square feet (28 m²) throughout the attic space. The markers shall be affixed to the trusses or joists and marked with the minimum initial installed thickness with numbers not less than 1 inch (25 mm) in height. Each marker shall face the attic access opening. The thickness and installed *R*-value of sprayed polyurethane foam insulation shall be indicated on the certification provided by the insulation installer.

N1104.2.3 ~~N1104.2.2~~ Batt-type insulation. Batt-type insulation shall be installed flush against the warm side of the cavity insofar as practicable.

N1104.2.4 ~~N1104.2.3~~ Insulation protection. Insulation exposed to the exterior shall be protected from physical and solar damage.

N1104.2.5 ~~N1104.2.4~~ Clearances. Recessed light fixtures shall be IC-labeled for direct insulation contact.

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.

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

N1104.2.6 ~~N1104.2.5~~ Baffles. Baffles of a durable rigid material shall be provided to prevent obstruction of vent openings and to deflect incoming air above the surface of porous insulation so as to prevent wind washing and blowing of loose material. Thermal insulation shall not be installed in a manner that would obstruct openings required for *attic* ventilation.

N1104.2.7 ~~N1104.2.6~~ 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) in accordance with manufacturer's specifications.
4. The top of the insulation shall be installed in a manner to allow water runoff and prevent pooling.

N1104.2.8 ~~N1104.2.7~~ Recessed lighting fixtures. Recessed lighting fixtures installed within the building thermal 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 not 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 (10 825 Pa) pressure difference 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 retarder or other air tight assembly manufactured for this purpose.

N1104.2.9 ~~N1104.2.8~~ Attic hatches, vertical doors and pull-down stairs to unconditioned spaces. Service doors between unconditioned and *conditioned spaces* shall meet the thermal requirements of Sections N1104.2.8.1 and N1104.2.8.2.

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N1104.2.9.1 Attic hatches. Access hatches from conditioned to unconditioned spaces such as attics and crawl spaces shall be insulated to the same R-value required by Table N1101.1(1) for the ceiling in which they are installed.

N1104.2.9.1.1 Access hatch installation and retention. Horizontal access hatches from conditioned spaces to unconditioned spaces such as attics and crawl spaces shall be weather-stripped. Access that prevents damaging or compressing the insulation shall be provided to all equipment. Where loose-fill insulation is installed, a wood-framed or equivalent baffle, retainer or dam shall be installed to prevent loose-fill insulation from spilling into living space from higher to lower sections of the attic and from attics covering conditioned spaces to unconditioned spaces. The baffle or retainer shall provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

N1104.2.9.2 ~~N1104.2.8.4~~ **Vertical doors.** *U*-factors for vertical doors providing access from conditioned to unconditioned spaces shall comply with the exterior door provisions of Table N1101.1(1).

N1104.2.9.3 ~~N1104.2.8.2~~ **Pull-down stairs.** Horizontal pull-down stair-type access hatches in ceiling assemblies that provide access from conditioned to unconditioned spaces shall have a maximum average *U*-factor of U-0.10 or an *R*-value of not less than R-10, have a net area of the framed opening not exceeding 13.5 square feet (1.25 m²), and have the perimeter of the hatch weatherstripped.

N1104.3 Exterior doors. Doors shall be tested and labeled 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.~~ Doors shall meet the air leakage requirements of Section N1104.8.

Exceptions:

1. Unglazed doors that are not tested according to the requirements of Section N1104.3 shall be assigned a default *U*-value of 0.54.
2. Sliding glass doors and swinging glass doors shall meet the specifications for windows and shall be treated as such.

N1104.4 Windows. All windows installed in Oregon shall meet the requirements of Part III, 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 does not need to be included in Table N1104.1(1) calculations.
2. Glass block assemblies may use a *U*-factor of 0.51.
3. The *U*-factor for windows may be a weighted average of total window area where all other building thermal envelope measures are in compliance with performance requirements specified in this code. This calculation shall be provided to the *building official* and the windows that are less than the required for prescriptive compliance shall be identified on the plans.

N1104.4.1 Thermal performance labeling. All *fenestrations* shall have labels. The labels shall be a National Fenestration Rating Council (NFRC) certified product or a state-approved label for windows produced in low volume. All labeling shall conform to the following requirements:

1. Be imprinted and not handwritten.
2. Face the interior of the room.
3. List the *U*-factor.
4. Be attached to the window until the building inspector inspects and verifies the labeling.

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.

N1104.4.2 Combined products. Where 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 Fenestration air leakage. Windows, skylights and sliding glass doors shall have an air infiltration rate of not greater than 0.3 cfm per square foot (1.5 L/s/m²), and for swinging doors, not greater than 0.5 cfm per square foot (2.6 L/s/m²) when tested in accordance with NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer.

Exception: Site-built windows, *skylights* and doors.

N1104.4.4 Alterations. New windows shall have a maximum *U*-factor as required by Table N1101.1(1).

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(1) 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.

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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 Table N1104.1(1), shall meet the following requirements:

1. Walls. Walls shall be framed with 2 × 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 three-stud corners configured to allow full insulation into the corner, or 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) to 2 inches (51 mm) in thickness shall be insulated with insulation that has a value of R-4 or greater per 1-inch (25.4 mm) thickness. Voids in headers greater than 2 inches (51 mm) in depth shall be insulated to a minimum level of R-10.

N1104.5.2 Intermediate framing for walls. Intermediate framing for walls is an optional construction method. Intermediate framing, when used to achieve improved wall performance under the requirements of Table 1101.1(1) or Table N1104.1(2), shall meet the following requirements:

1. Walls. Walls shall be framed with 2 × studs at 16 inches (406 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 three-stud corners configured to allow full insulation into the corner, or 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) to 2 inches (51 mm) in thickness shall be insulated with insulation that has a value of R-4 or greater per 1-inch (25.4 mm) thickness. Voids in headers greater than 2 inches (51 mm) in depth shall be insulated to a minimum level of R-10.

N1104.5.3 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 shall 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). The minimum total distance of 24 inches (610 mm) may be a combination of the horizontal and vertical planes. If a horizontal plane is used on the exterior of the slab, it shall be a minimum of 12 inches (305 mm) below finished grade.

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

N1104.7.1 Slab-on-grade floors with hydronic heat. For slab-on-grade floors that incorporate hydronic heating, in addition to perimeter insulation, the entire underside of the slab shall be insulated to R-10.

N1104.8 Air leakage. The building thermal envelope shall be constructed to limit air leakage in accordance with this section.

N1104.8.1 Air barriers. A *continuous air barrier* shall be installed and fully aligned with the *building thermal envelope* on every vertical portion of air-permeable insulation and on the warm side of horizontal, air-permeable insulation. Air-permeable insulation shall not be used as a sealing material.

Exception: Unvented *attics*, continuous insulation walls and similar conditions where an impermeable insulation layer forms an air barrier.

N1104.8.2 Sealing required. Exterior joints around window and door frames; between wall cavities and window or door frames; between walls and foundation; between walls 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*. Sealing for the purpose of creating a *continuous air barrier* shall be in accordance with the applicable requirements of Table N1104.8, or the *dwelling* shall be tested to demonstrate a blower door result not greater than 3.25 ACH50.

New buildings using Section N1105.3, Exception 3, shall be tested to demonstrate a blower door result not greater than 3.25 ACH50.

N1104.8.2.1 Top plate sealing. At all walls in contact with vented *attics*, the wall covering (gypsum board or other) shall be sealed to the top plate with caulk, sealant, gasket or other *approved* material.

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TABLE N1104.8—AIR BARRIER INSTALLATION AND AIR SEALING REQUIREMENTS	
COMPONENT	AIR BARRIER CRITERIA
General requirements	A continuous air barrier shall be installed in alignment with the building thermal envelope. Breaks or joints in the air barrier shall be sealed.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop-down stairs, or knee wall doors to unconditioned attic spaces shall be gasketed and sealed.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of interior walls shall be sealed between wall cavities and windows or door frames. All penetrations or utility services through the top and bottom plates shall be sealed. Knee walls shall be sealed.
Windows, skylights and doors	The annular space between framing and skylights, and the jambs of windows and doors shall be air sealed. Framing cavities around windows, skylights and doors shall contain continuous insulation or be installed per the fenestration manufacturer's instructions.
Rim/band joists	Rim/band joists shall be a part of the thermal envelope and have a continuous air barrier.
Floors Including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.
Shafts, penetrations	Duct shafts, utility penetrations and flue shafts opening to exterior or unconditioned space shall be sealed.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be sealed to the finished surface.
Shower/tub on exterior walls	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.
HVAC register boots	HVAC supply and return register boots that penetrate the building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.

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.

N1104.9.1 Vapor retarders. Vapor retarders shall be installed in accordance with Section R318.

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 installed in accordance with Chapter 4.

SECTION N1105—HEATING, VENTILATING AND AIR-CONDITIONING SYSTEMS

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

N1105.2 Insulation of ducts. All new duct systems or new portions of duct systems exposed to unconditioned spaces, and buried ductwork within insulation that meets the exception to Section N1105.3, shall be insulated to minimum R-8.

Exceptions:

1. The replacement or addition of a furnace, air conditioner or heat pump shall not require existing ducts to be insulated to current code.
2. Exhaust and intake ductwork.

N1105.3 Installation of ducts and air handling equipment. For new construction and *additions*, all new duct systems and air handling equipment and *appliances* shall be located fully within the *building thermal envelope*.

Exceptions:

1. Ventilation intake ductwork and exhaust ductwork.
2. Up to 10 feet (3048 mm) of HVAC ductwork.
3. Where ~~two~~ three measures are selected from Table N1101.1(2) and HVAC supply and return ductwork is installed in accordance with Section N1105.3.1 and either Section ~~N1105.3.1~~, N1105.3.2, ~~or~~ N1105.3.3 or N1105.3.4.

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N1105.3.1 Ductwork Leakage. Ductwork, as measured either by a rough-in test of the supply and return ductwork or a post construction duct system leakage test to outside the building thermal, is less than or equal to not greater than 3 cubic feet per minute (cfm) (85 L/min) per 100 square feet (9.29 m²) of conditioned floor area served by the duct system.

N1105.3.1.1 Duct System Testing. Each duct system outside the thermal envelope shall be tested for air leakage in accordance with ANSI/RESNET/ICC 380 or ASTM E1554. Total leakage shall be measured with a pressure differential of 0.1 inch water gauge (25 Pa) across the duct system and shall include the measured leakage from the supply and return ductwork. A written report of the test results shall be signed by the party conducting the test and provided to the building official.

N1105.3.2 ~~**N1105.3.4**~~ **Deeply buried duct in attic.** Ducts deeply buried in *attic* insulation shall be in accordance with all of the following when using Section N1105.3, Exception 3:

1. Insulation shall be installed to fill gaps and voids between the duct and the ceiling, and a minimum of R-19 insulation shall be installed above the duct between the duct and unconditioned *attic*.
2. All ductwork in the *attic* shall be insulated to R-8.
3. Insulation depth marker flags shall be installed on the ducts every 10 feet (3048 mm) or as *approved* by the *building official*.

Exception: HVAC ductwork shall be permitted to be located outside of the *building thermal envelope* where the duct is insulated to a minimum of R-27 with a Class II or III vapor retarder.

N1105.3.3 ~~**N1105.3.2**~~ **Ducts in an unvented crawl space outside the building thermal envelope.** Ducts located in an unvented *crawl space* outside of the *building thermal envelope* shall be in accordance with all of the following when using Section N1105.3, Exception 3:

1. In addition to meeting Section R408.3, all seams of the vapor barrier shall overlap a minimum of 12 inches (305 mm) and be sealed with tape or other *approved* method.
2. All ductwork in the *crawl space* shall be insulated to R-8.
3. The floor between the *crawl space* and the *dwelling* shall be insulated with minimum R-30.

N1105.3.4 ~~**N1105.3.3**~~ **Deeply buried duct in vented crawl space.** Ducts deeply buried in *crawl space* insulation shall be in accordance all of the following when using Section N1105.3, Exception 3:

1. Insulation shall be installed to fill gaps and voids between the duct and the floor above, and a minimum of R-19 insulation shall be installed below the duct and between the duct and unconditioned *crawl space*.
2. All ductwork in the *crawl space* shall be insulated to R-8.
3. The floor between the *crawl space* and the *dwelling* shall be insulated with minimum R-30.

Exception: HVAC ductwork shall be permitted to be located outside of the *building thermal envelope* where the duct is insulated to a minimum of R-27 with a Class II or III vapor retarder.

N1105.4 HVAC controls. All *heating, ventilating and air-conditioning systems* shall be provided controls as specified herein.

N1105.4.1 Temperature controls. 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 55°F to 75°F (13°C to 24°C) where used to control heating only and from 70°F to 85°F (21°C to 29°C) where used to control cooling only. Where used to control both heating and cooling, it shall be capable of being set from 55°F to 85°F (13°C to 29°C) 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 5°F (2.8°C) within which the supply of heating and cooling energy to the zone is shut off or reduced to a minimum.

N1105.4.1.1 Setback and shutoff. The thermostat shall provide a readily accessible 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 kilowatts (6824 Btu/h) or less may be controlled by readily accessible off-hour controls.

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

N1105.4.1.2 Smart thermostat. For new construction, the thermostat shall meet ENERGY STAR Smart Thermostat criteria with minimum control feature of either integral occupancy sensing or geofencing or *approved* equivalent.

Exception: Where approved, individual heating or cooling units with heating capacity of 2 kilowatts (6824 Btu/h) or less, or with cooling ~~capacity of less than 5.3 kilowatts (18 000 Btu/h)~~ that uses variable speed compressors where the manufacturer's thermostat is required.

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N1105.4.1.3 Heat pump controls. ~~Heat pumps having supplementary electric- resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load. fuel gas or liquid fuel heating systems shall have controls that are configured to prevent supplemental heat operation when the capacity of the heat pump compressor can meet the heating load. Supplemental heat operation shall be limited to only where one of the following applies:~~

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The thermostat malfunctions.
5. In response to utility demand response signal.

N1105.4.2 Humidity. If a *heating, ventilating and air-conditioning system* is equipped with a means for adding moisture to maintain specific selected relative humidity 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 humidity 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.

N1105.4.3 Temperature zoning. Each separate *heating, ventilating and air-conditioning system* shall be provided with 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 noncooled basements and garages.

N1105.5 Outside combustion air. See Section R1006 for required outside combustion air for masonry fireplaces, factory-built fireplace and factory-built stoves.

N1105.6 Ventilation fan efficiency. Bathroom exhaust fans and ~~outdoor whole-house~~ ventilation ~~air supply~~ fans shall be ENERGY STAR certified and comply with Table N1105.6.

~~A fan that is the air mover for a heating or cooling system that serves an individual dwelling unit shall not be used to provide outdoor air except where its fan efficacy is not less than 1.2 cubic feet per minute (cfm) (0.566 L/s) of outdoor airflow per watt when there is no demand for heating or cooling.~~

TABLE N1105.6—FAN EFFICACY FOR WHOLE-HOUSE MECHANICAL VENTILATION SYSTEMS AND OUTDOOR AIR VENTILATION SYSTEMS^a			
SYSTEM TYPE	AIRFLOW RATE (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE
<u>HRV or ERV</u>	<u>Any</u>	<u>1.2^a</u>	<u>CAN/CSA C439</u>
<u>Balanced ventilation system without heat or energy recovery</u>	<u>Any</u>	<u>1.2^a</u>	<u>ANSI/AMCA 210-ANSI/ASHRAE 51</u>
<u>In-line supply or exhaust fan</u>	<u>Any</u>	<u>3.8</u>	
<u>Other exhaust fan</u>	<u>< 90</u>	<u>2.8</u>	
	<u>≥ 90 and < 200</u>	<u>3.5</u>	
	<u>≥ 200</u>	<u>4.0</u>	
For SI: 1 square foot = 0.093 m ² , 1 watt per square foot = 10.8 W/m ² a. For balanced ventilation systems, HRVs and ERVs, determine the efficacy as the outdoor airflow rate (cfm) divided by the total fan power (W).			

N1105.7 Central fan integrated supply (CFIS) systems. An HVAC system shall not be used to provide whole-house ventilation.

~~**N1105.7 Furnace fan efficiency.** New central furnaces shall have electronically commutated fan motors with a fan efficiency rating meeting US DOE 10 CFR 430.32(y).~~

N1105.8 Heat pump. In new dwellings where split-system air-conditioning is installed, the outdoor condensing unit and indoor evaporator coil shall have heat pump operation that provides both heating and cooling.

SECTION N1106—PIPING INSULATION

N1106.1 Mechanical system piping insulation. Mechanical system piping capable of carrying fluids above 105°F (40.5°C) or below 55°F (13°C) shall be insulated to a minimum of R-3.

N1106.2 Domestic and service hot water systems. Domestic hot water piping shall be insulated to a minimum of R-3 at the following locations:

1. Pipe not located fully within the *conditioned space* .
2. The first 8 feet (2438 mm) of pipe into and out of a water heater.
3. Recirculating water piping.

N1106.3 Protection of piping insulation. Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. The protection shall provide shielding from solar radiation that can cause degradation

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of the material. Adhesive tape shall not be used for protection system.

SECTION N1107—LIGHTING AND POWER

N1107.1 General. The provisions of this section apply to power and lighting equipment, related controls and electric circuits serving all conditioned and unconditioned interior floor space and exterior building facades of all *dwelling units* and guest rooms within residential buildings and structures, or portions thereof.

N1107.2 High-efficiency interior lighting. All permanently installed lighting fixtures shall be *high-efficiency light sources*.

The building official shall be notified in writing at the final inspection that the permanently installed lighting fixtures have met this requirement.

~~Exception: Two permanently installed lighting fixtures are not required to be *high-efficiency light sources* when controlled by a dimmer or automatic control.~~

N1107.3 High-efficiency exterior lighting. All exterior lighting fixtures affixed to the exterior of the building shall be *high-efficiency light sources*.

~~Exception: Two permanently installed lighting fixtures are not required to be *high-efficiency light sources* when controlled by automatic control.~~

N1107.4 Occupancy sensors. Occupancy sensor shall be installed per N1107.4.1 and N1107.4.2

N1107.4.1 Habitable spaces. All permanently installed luminaires in *habitable spaces* shall be controlled with a *manual* dimmer or with an automatic shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.

N1107.4.2 Specific locations. All permanently installed luminaires in garages, unfinished basements, laundry rooms and utility rooms shall be controlled with a *manual* dimmer or by an automatic shutoff control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a *manual* control to allow occupants to turn the lights on or off.

SECTION N1108—PLUMBING FIXTURE EFFICIENCY

N1108.1 General. This section shall apply to plumbing fixture efficiency.

N1108.1.1 Fixture efficiency. Fixture efficiency shall be per the *Plumbing Code*.

PART 2—ALTERNATIVE SYSTEMS ANALYSIS

SECTION NA1109 ENERGY RATING INDEX (ERI) COMPLIANCE

NA1109.1 Scope. This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis.

NA1109.2 ERI compliance. Compliance based on the ERI requires that the *proposed design* has a score less than or equal to the values in Table NA1109.2 when compared to the *ERI reference design* determined in accordance with RESNET/ICC 301, excluding onsite power production (OPP).

TABLE NA1109.2—MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX (Not including OPP)
4C	54 53
5C	55 54

NA1109.3 Building thermal envelope. The *proposed design* total building thermal envelope performance (UA) shall be less than or equal to the total *standard reference design* building thermal envelope performance UA using the prescriptive U-factors, C-Factors, and F-factors from Table N1101.1(1) multiplied by 1.10 in accordance with Equation 11-1 and N1104.1

Equation 11-1: $UA_{\text{Proposed design}} \leq 1.10 \times UA_{\text{Prescriptive code design}}$

NA1109.4 Verification by approved agency. Verification of compliance with Section NA1109 as outlined in Section NA1109.1 shall be completed by the *building official* or an approved third-party inspection agency in accordance with Section **R109.2**.

NA1109.5 Documentation. Documentation of the software used to determine the ERI and the parameters for the *residential building* shall be in accordance with Sections NA1109.5.1 through NA1109.5.5.

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NA1109.5.1 Compliance software tools. Software tools used for determining ERI shall be Approved Software Rating Tools in accordance with RESNET/ICC 301.

NA1109.5.2 Compliance report. Compliance software tools shall generate a report that documents that the home and the ERI score of the *rated design* comply with Section NA1109.1. Compliance documentation shall be created for the proposed design and shall be submitted with the application for the building *permit*. Confirmed compliance documents of the built *dwelling unit* shall be created and submitted to the *building official* for review before a certificate of occupancy is issued. Compliance reports shall include information in accordance with Sections NA1109.5.2.1 and NA1109.5.2.2.

NA1109.5.2.1 Proposed compliance report for permit application. Compliance reports submitted with the application for a building *permit* shall include the following:

1. Building street address, or other *building site* identification.
2. Declare ERI on title page and building plans.
3. The name of the individual performing the analysis and generating the compliance report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
6. A document indicating that the proposed design has an ERI less than or equal to the appropriate score indicated in Table NA1109.1 when compared to the *ERI reference design*. The certificate shall document the building component energy specifications that are included in the calculation, including: component level insulation *R*-values or *U*-factors; assumed duct system and building envelope air leakage testing results; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation, and service water-heating equipment to be installed. If on-site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.
7. Where a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated home.

NA1109.5.2.2 Confirmed compliance report for a certificate of occupancy. A confirmed compliance report submitted for obtaining the certificate of occupancy shall be made site and address specific and include the following:

1. Building street address or other *building site* identification.
2. Declaration of ERI on title page and on building plans.
3. The name of the individual performing the analysis and generating the report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
6. A final confirmed document indicating that the confirmed *rated design* of the built home complies with Section NA1109.1. The certificate shall report the energy features that were confirmed to be in the home, including: component-level insulation *R*-values or *U*-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation, and service water-heating equipment installed. Where on-site renewable energy systems have been installed on or in the home, the certificate shall report the type and production size of the installed system.

NA1109.5.3 Additional documentation. The *building official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *ERI reference design*.
2. A certification signed by the builder providing the building component characteristics of the *rated design*.
3. Documentation of the actual values used in the software calculations for the *rated design*.

NA1109.5.4 Input values. Where calculations require input values not specified by Sections N1101, N1104, N1105, N1106, N1107 and N1108, those input values shall be taken from RESNET/ICC 301.

SECTION NA1110 SIMULATED BUILDING PERFORMANCE COMPLIANCE

NA1110.1 Scope. This section establishes criteria for compliance using *simulated building performance analysis*. Such analysis shall include HVAC (*heating, ventilating and air-conditioning*) systems and service water-heating energy only. Such analysis shall be limited to *new dwelling units*.

NA1110.2 Simulated building performance compliance. Compliance based on *simulated building performance* requires that a *building* comply with the following:

1. The requirements of N1103-N1108 unless allowed for trade-off under Section N1110.4.
2. The Proposed Design total building thermal envelope performance (Proposed UA) shall be less than or equal to the Standard Reference Design (SRD) total building thermal envelope performance (SRD UA) using the prescriptive U-factors, C-Factors, and F-factors from Table N1102.1.1(1) multiplied by 1.10 in accordance with Equation 11-1 and Section N1104.1.
3. For each dwelling unit the annual energy cost of the proposed design shall be less than or equal to 85 percent of the annual energy cost of the standard reference design. Energy prices shall be taken from the State of Oregon Building Code Division Residential cost-per-unit of energy document, or an approved source, such as the US Energy Information Administration's State Energy Data

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System prices and expenditures reports. *Building official's* shall be permitted to require time-of-use pricing in *energy cost* calculations.

Exception: The energy use based on site energy expressed in *Btu* or *Btu* per square foot of *conditioned floor area* shall be permitted to be substituted for the *energy cost*.

N1110.3 Verification by approved agency. Verification of compliance with Section NA1110 shall be completed by the *building official* or an *approved* third-party inspection agency in accordance with Section R109.2 Certification by an approved agency.

N1110.4 Compliance documentation. The following compliance reports, which document the performance of the *standard reference design*, the *proposed design*, and the performance of the as-built *dwelling unit* comply with the requirements of Section N1110, shall be submitted to the *building official*.

1. A compliance report in accordance with Section N1110.6.4.1 shall be submitted with the application for the building *permit*.
2. A compliance report in accordance with Section N1110.6.4.2 shall be submitted before a certificate of occupancy is issued.

N1110.5 Calculation procedure. Performance calculations shall be in accordance with Sections N1110.5.1, N1110.5.2 and N1110.5.3. Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

N1110.5.1 General. Calculation procedures used to comply with Section N1110 shall use a software tool, *approved* software in accordance with Section N1110.6, capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design*.

N1110.5.2 Residence specifications. The *standard reference design*, *proposed design* and as-built *dwelling unit* shall be configured and analyzed as specified by Table N1110.5.2(1). Table N1110.5.2(1) shall include, by reference, all notes contained in Table N1101.1(1). Proposed *U-factors*, *C-Factors*, and slab-on-grade *F-factors* shall be taken from Table N1104.1(2), ANSI/ASHRAE/IES 90.1 Appendix A, or determined using a method consistent with the ASHRAE Handbook of Fundamentals and shall include the thermal bridging effects of framing materials.

TABLE N1110.5.2(1)—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass where the proposed wall is a mass wall; otherwise wood frame.	As proposed.
	Gross area: same as proposed.	As proposed.
	U-factor: as specified in Table N1101.1(1)	As proposed.
	Solar reflectance = 0.25.	As proposed.
	Emittance = 0.90.	As proposed.
Basement and crawl space walls (below grade walls)	Type: same as proposed.	As proposed.
	Gross area: same as proposed.	As proposed.
	C-Factor: as specified in Table N1101.1(1)	As proposed.
Above-grade floors	Type: wood frame.	As proposed.
	Gross area: same as proposed.	As proposed.
	U-factor: as specified in Table N1101.1(1)	As proposed.
Ceilings	Type: wood frame.	As proposed.
	Gross area: same as proposed.	As proposed.
	U-factor: as specified in Table N1101.1(1)	As proposed.
Roofs	Type: composition shingle on wood sheathing.	As proposed.
	Gross area: same as proposed.	As proposed.
	Solar reflectance = 0.25.	As proposed.
	Emittance = 0.90.	As proposed.
Attics	Type: vented with an aperture of 1 ft ² per 300 ft ² of ceiling area.	As proposed.
Foundations	Type: same as proposed.	As proposed.
	Foundation wall extension above and below grade: same as proposed. Foundation wall or slab perimeter length: same as proposed. Soil characteristics: same as proposed.	As proposed.
	Foundation wall U-factor and slab-on-grade F-factor: as specified in Table N1101.1(1)	
Opaque doors	Area: 40 ft ² .	As proposed.
	Orientation: North.	As proposed.
	U-factor: same as fenestration as specified in Table N1101.1(1)	As proposed.

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<u>TABLE N110.5.2(1) [R405.4.2(1)]—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued</u>		
<u>BUILDING COMPONENT</u>	<u>STANDARD REFERENCE DESIGN</u>	<u>PROPOSED DESIGN</u>
Vertical fenestration other than opaque doors	Total area ^g = (a) <u>The proposed glazing area, where the proposed glazing area is less than 12 percent of the conditioned floor area.</u> (b) <u>12 percent of the conditioned floor area, where the proposed glazing area is 12 percent or more of the conditioned floor area.</u>	As proposed.
	Orientation: <u>equally distributed to four cardinal compass orientations (N, E, S & W).</u>	As proposed.
	U-factor: <u>as specified in Table N1101.1(1)</u>	As proposed.
	SHGC: <u>same as proposed design</u>	As proposed.
	Interior shade fraction: <u>0.92 – (0.21 × SHGC for the standard reference design), same as proposed design</u>	As proposed.
	External shading: <u>none</u>	As proposed.
Skylights	None	As proposed.
Thermally isolated sunrooms	None	As proposed.
Air leakage rate	The air leakage rate at a pressure of 0.2 inch water gauge (50 Pa) shall be 3.0 air changes per hour. For <i>small homes</i> , the air leakage rate at a pressure of 0.2 inch water gauge (50 Pa) shall be 0.15 cfm/ft ² of the testing unit enclosure area.	For permit application: 3 ACH50. For certificate of occupancy: The measured air leakage rate ^a .
Mechanical ventilation rate	The whole-house balanced mechanical ventilation rate shall be continuous per Section M1505.4.3	Same as standard reference design
Mechanical ventilation fan energy	The whole-house balanced mechanical ventilation system efficiency shall be per Table N1105.6	As proposed.
Internal gains	Gain, in units of Btu/day per dwelling unit, shall equal $17,900 + 23.8 \times CFA + 4,104 \times N_{br}$ where: <u>CFA = conditioned floor area, ft².</u> <u>N_{br} = number of bedrooms.</u>	Same as standard reference design.
Internal mass	Internal mass for furniture and contents: 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element ^b but not integral to the building thermal envelope or structure.
Structural mass	For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed.
	For masonry basement walls: as proposed, but with insulation as specified in Table N1101.1(1), located on the interior side of the walls.	As proposed.
	For other walls, ceilings, floors, and interior walls: wood-framed construction.	As proposed.
Heating systems ^{c, d, i, j}	Fuel Type/Capacity: same as proposed design. Where cooling is provided, first stage of heating shall comply with Section N1105.8 Heat Pump. Swap over temperature shall be 35F.	As proposed.
	Product class: same as proposed design.	As proposed.
	Efficiencies: Heat pump: complying with 10 CFR §430.32	As proposed.
	Fuel gas and liquid fuel furnaces: complying with 10 CFR §430.32	As proposed.
	Fuel gas and liquid fuel boilers: complying with 10 CFR §430.32	As proposed.
Cooling systems ^{c, e, j}	Fuel Type: electric Capacity: same as proposed design	As proposed.
	Efficiencies: complying with 10 CFR §430.32	As proposed.

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<u>TABLE N1105.2(1) [R405.4.2(1)]—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued</u>		
<u>BUILDING COMPONENT</u>	<u>STANDARD REFERENCE DESIGN</u>	<u>PROPOSED DESIGN</u>
<u>Service water heating^{c, e, j}</u>	Use, in units of gal/day = $25.5 + (8.5 \times N_{br})$ where: N_{br} = number of bedrooms.	Use, in units of gal/day = $25.5 + (8.5 \times N_{br}) \times (1 - HWDS)$ where: N_{br} = number of bedrooms. $HWDS$ = factor for the compactness of the hot water distribution system.
		Compactness ratio^h factor HWDS
		1. story 2. or more stories
		> .60% > .30% 0
		> .30% to ≤ .60% > .15% to ≤ .30% 0.05
		> .15% to ≤ .30% > .7.5% to ≤ .15% 0.10
		≤ .15% ≤ .7.5% 0.15
		Fuel type: same as proposed design As proposed.
	Rated storage volume: same as proposed design As proposed.	
	Draw pattern: same as proposed design As proposed.	
	Efficiencies: Uniform Energy Factor (UEF) complying with 10 CFR §430.32 As proposed.	
	Tank temperature: 120°F (48.9°C) Same as standard reference design.	
<u>Thermal distribution systems</u>	Duct insulation: in accordance with Section N1105.2	Duct insulation: as proposed. ^l
	Duct location: Fully within the building thermal envelope, except ventilation intake ductwork and exhaust ductwork. Sections N1105.3.2, or N1105.3.3 or N1105.3.4 shall not apply.	Duct location: as proposed. ^l
	Duct system leakage to outside: 0	If ducts inside per N1105.3, without use of Exception 3: Same as standard reference design. Where using N1105.3 Exception 3: <ul style="list-style-type: none"> • For permit application: 3 cubic feet per minute (cfm) per 100 square feet. • For certificate of occupancy: The measured air leakage rate^m.
	Distribution System Efficiency (DSE): for hydronic systems and ductless systems a thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies.	Same as standard reference design
<u>Thermostat</u>	Type: Manual, cooling temperature setpoint = 76°F; Heating temperature setpoint = 71°F.	Same as standard reference design.
<u>Dehumidistat</u>	Where a mechanical ventilation system with latent heat recovery is not specified in the proposed design: None. Where the proposed design utilizes a mechanical ventilation system with latent heat recovery: Dehumidistat type: manual, setpoint = 60% relative humidity. Dehumidifier: whole-dwelling with integrated energy factor = 1.77 liters/kWh.	Same as standard reference design.

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TABLE N1110.5.2(1) [R405.4.2(1)]—SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS—continued

For SI: 1 square foot = 0.93 m², 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m², 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad, 1 cubic foot per minute = 28.317 L/min.

- a. Hourly calculations as specified in the ASHRAE Handbook of Fundamentals, or the equivalent, shall be used to determine the energy loads resulting from infiltration.
- b. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.
- c. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.
- d. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.
- e. For a proposed design without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.
- f. For a proposed design without a proposed water heater, the following assumptions shall be made for both the proposed design and standard reference design:
 - Fuel Type: Same as the predominant heating fuel type
 - Rated Storage Volume: 50 gallons
 - Draw Pattern: Medium
 - Efficiency: Uniform Energy Factor (UEF) complying with 10 CFR §430.32
- g. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

$$AF = A_s \times FA \times F$$
 where:
 - AF = Total glazing area.
 - A_s = Standard reference design total glazing area.
 - FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).
 - F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater, and where:
 - Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.
 - Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
 - Below-grade boundary wall is any thermal boundary wall in soil contact.
 - Common wall area is the area of walls shared with an adjoining dwelling unit.
- h. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the "hot water rectangle") divided by the floor area of the dwelling.
 1. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.
 2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
 3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.
 4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.
 5. The basement or attic shall be counted as a story when it contains the water heater.
 6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and HWDS factor.
- i. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.
- j. For heating systems, cooling systems, or water heating systems not included in this table, the standard reference design shall be the same as proposed design.
- k. Only sections of ductwork that are installed in accordance with Section N1105.3, not including Exception 3, are assumed to be located completely inside conditioned space. All other sections of ductwork are not assumed to be located completely inside conditioned space.
- l. Sections of ductwork installed in accordance with Section N11105, which utilize Exception 3 are assumed to have an effective duct insulation R-value of R-27.
- m. Duct system leakage to outside: The measured total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate.

Exceptions:

 1. Where duct system leakage to outside is tested in accordance ANSI/RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered.
 2. Where total duct system leakage is measured without space conditioning equipment installed, the simulation value shall be 4 cfm per 100ft² of conditioned floor area.

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N1110.5.3 Input values. When calculations require input values not specified by Sections N1104, N1105, N1106 and N1107, N1108, and N1110, those input values shall be taken from an *approved* source.

N1110.6 Calculation software tools. Performance analysis tools, such as REM/Rate, Ekotrope, Energy Guage, APEX, and DOE2, meeting the applicable provisions of Sections N1110.6.1 through N1110.6.4 shall be permitted to be *approved* by the *building official*. Tools are permitted to be *approved* based on meeting a specified threshold for a *municipality*. The *building official* shall be permitted to approve such tools for a specified application or limited scope.

N1110.6.1 Minimum capabilities. *Approved* software tools shall include the following capabilities:

1. Computer generation of the *standard reference design* and the *proposed design*.
2. Calculation of whole-dwelling unit (as a single *zone*) sizing for the heating and cooling *equipment* in the *standard reference design* residence in accordance with Section M1401.3.
3. Hourly calculations of building operation for a full calendar year (8,760 hours).
4. Calculations that account for hourly variations of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning *equipment* based on climate and *equipment* sizing.
5. Printing of a *building official* inspection checklist listing each of the *proposed design* component characteristics from Table N1110.4.2(1) determined by the analysis to provide compliance, along with their respective performance ratings such as *R-value*, *U-factor*, *SHGC*, *HSPF2*, *AFUE*, *SEER2* and *UEF*.

N1110.6.2 Testing required by software vendors. Prior to approval, software tools shall be tested by the software vendor in accordance with ANSI/ASHRAE 140 Class II, Tier 1 test procedures. During testing, hidden inputs that are not normally available to the user shall be permitted to avoid introducing source code changes strictly used for testing. Software vendors shall publish, on a publicly available website, the following ANSI/ASHRAE 140 test results, input files and modeler reports for each tested version of a software tool:

1. Test results demonstrating the software tool was tested in accordance with ANSI/ASHRAE 140.
2. The modeler report in ANSI/ASHRAE 140, Annex A2, Attachment A2.7.

N1110.6.3 Algorithms not tested. Algorithms not tested in accordance with Section N1110.5.2 shall be permitted in accordance with ANSI/RESNET/ICC 301. Numerical settings not tested, such as timestep duration and tolerances, shall be permitted when they represent a higher resolution than the numerical settings used for testing.

N1110.6.4 Compliance reports. *Approved* software tools shall generate compliance reports in accordance with Sections N1105.6.4.1 and N1105.6.4.2.

N1110.6.4.1 Compliance report for permit application. A compliance report generated for submission with the application for building *permit* shall include the following:

1. Building street address or other *building site* identification.
2. The name of the individual performing the analysis and generating the compliance report.
3. The name and version of the compliance software tool.
4. Documentation of all inputs to the software used to produce the results for the *standard reference design* and the *proposed design*.
5. A document indicating that the *standard reference design* and *proposed design* comply with Section N1110.2. The certificate shall document the building components' energy specifications that are included in the calculation including: component-level insulation *R-values* or *U-factors*; *duct system* and *building thermal envelope* air leakage testing assumptions; and the type and rated efficiencies of proposed heating, cooling, mechanical *ventilation* and service water-heating *equipment* to be installed.
6. Where *on-site renewable energy* systems will be installed, the certificate shall report the type and production size of the proposed system.
7. Where a site-specific report is not generated, the *proposed design* shall be based on the worst-case orientation and configuration of the rated *dwelling unit*.

N1110.6.4.2 Compliance report for certificate of occupancy. A compliance report generated for submission prior to obtaining the certificate of occupancy shall include the following:

1. Building street address or other *building site* identification.
2. A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built *building* complies with Section N1110.2.
3. The name and version of the compliance software tool.
4. A site-specific *energy analysis* report that is in compliance with the requirements of Section N1110.5, where all inputs for the *proposed design* have been replaced in the simulation with confirmed energy features of the as-built *dwelling unit*.

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~~5. A final confirmed document indicating compliance based on inspection, and a statement indicating that the as-built building complies with Section N1110.2. The certificate shall report the energy features that were confirmed to be in the building, including component-level insulation R-values or U-factors; results from any required duct system and building thermal envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation and service water-heating equipment installed.~~

~~6. When on-site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system.~~

~~NA1110.7 Additional documentation. The building official shall be permitted to require the following documents:~~

- ~~1. Documentation of the building component characteristics of the standard reference design.~~
- ~~2. A certification signed by the builder providing the building component characteristics of the proposed design.~~
- ~~3. Documentation of the actual values used in the software calculations for the proposed design.~~

PART 3 FENESTRATION STANDARD

SECTION NF1110—SCOPE

NF1110.1 General. All windows installed in Oregon shall meet the requirements of this section.

SECTION NF1111—ALTERATIONS

NF1111.1 Windows. Windows shall be tested and labeled in accordance with Section N1104.4.

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

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

1. Decorative or unique architectural feature 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 N1104.1(1) calculations.
2. Glass block assemblies may use a *U*-factor of 0.51.
3. The *U*-factor for windows may be a weighted average of total window area where all other building thermal envelope measures are in compliance with performance requirements specified in this code. This calculation shall be provided to the *building official* and the windows that are less than the required for prescriptive compliance shall be identified on the plans.

SECTION NF1112—DEFINITIONS

NF1112.1 General. For purposes of this section the following definitions are provided:

ALUMINUM WITH VINYL. Fenestration framing material consisting of a composite of both aluminum and vinyl framing constructed in a manner where the aluminum framing is provided a complete thermal break by the vinyl framing.

MANUFACTURER. 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.

SUNROOM/SOLARIUM. A one-story structure attached to a *dwelling* with a *glazing area* in excess of 40 percent of the gross area of that structure's *exterior walls* and roof.

WINDOWS PRODUCED IN LOW VOLUME. A manufacturer's product installed in Oregon during a calendar year that does not exceed: 750 windows, 500 glazed doors, 1,000 *skylights* covered in Section NF1114.2 and 25 complete sunrooms/solariums.

SECTION NF1113—INSULATING GLASS CERTIFICATION

NF1113.1 General. Sealed insulating glass units shall conform to ASTM E2190 and shall be certified by an accredited insulating glass unit certification program.

SECTION NF1114—WINDOW THERMAL PERFORMANCE DESIGNATION FOR NEW BUILDINGS AND ADDITIONS

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

NF1114.1 Manufactured windows. *U*-factors for manufactured fenestration products (windows, skylights and doors) shall be determined in accordance with the NFRC 100. The *U*-factors shall be labeled and certified in accordance with the NFRC Product Certification.

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NF1114.2 Window products exempt from testing. The following products are exempt from thermal performance testing as specified in Section NF1114.1.

1. Windows produced in low volume.
2. Glazing not exceeding 1 percent of the heated space floor area.
3. Solariums and sunrooms.
4. *Skylights* constituting no more than 10 percent of total glazing in a residential building.
5. *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-emissivity glass or triple-layered acrylic.

NF1114.2.1 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 as specified in Section NF1114.3, Item 1.
2. Glazed doors produced in low volume are assigned default *U*-factors as specified in Section NF1114.3, Item 2.
3. *Skylights* produced in low volume are assigned default *U*-factors as specified in Section NF1114.3, Item 3.
4. *Skylights* constituting not more than 10 percent of total glazing in a residential building that are exempt from testing are assigned default *U*-factors as specified in Section NF1114.3, Item 3.
5. Vertical and overhead glazing contained in sunrooms/solariums are assigned default *U*-factors as specified in Section NF1114.3, Items 1, 2 and 4.
6. *Skylights* specified in Section NF1114.2, Item 5 shall be assigned a default *U*-factor of 0.50.

NF1114.3 Thermal performance validation for windows produced in low volume or site built. *Windows*, glazed doors, *skylights* and *sunroom/solariums* produced in low volume and meeting the requirements of this subsection may validate default *U*-factors:

1. By using Table NF1114.3(1) for *windows*.
2. By using Table NF1114.3(2) for glazed doors.
3. By using Table NF1114.3(1) for *skylights* based on an overall *U*-factor of U-0.50.
4. By using Table NF1114.3(1) for overhead *glazing* installed in *sunrooms/solariums* based on an overall *U*-factor of U-0.35.

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TABLE NF1114.3(1)—APPROVED WINDOW DEFAULT U-VALUES ^{a, b}			
DESCRIPTION ^{c, d, e, f, g} (inches)	FRAME TYPE ^h		
	ALUMINUM THERMAL BREAK ⁱ	WOOD/VINYL	ALUMINUM CLAD WOOD/REINFORCED VINYL ^j
Double, Clear 1/4	N/A	0.56	0.59
Double, Clear 1/4 + argon	0.63	0.53	0.56
Double, Low-e 4, 1/4	0.61	0.52	0.54
Double, Low-e 2, 1/4	0.58	0.49	0.51
Double, Low-e 1, 1/4	0.55	0.47	0.49
Double, Low-e 4, 1/4 + argon	0.55	0.47	0.49
Double, Low-e 2, 1/4 + argon	0.52	0.43	0.46
Double, Low-e 1, 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-e 4, 3/8	0.57	0.48	0.51
Double, Low-e 2, 3/8	0.54	0.45	0.48
Double, Low-e 1, 3/8	0.51	0.43	0.46
Double, Low-e 4, 3/8 + argon	0.53	0.44	0.47
Double, Low-e 2, 3/8+ argon	0.49	0.41	0.44
Double, Low-e 1, 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-e 4, 1/2	0.53	0.44	0.47
Double, Low-e 2, 1/2	0.50	0.41	0.44
Double, Low-e 1, 1/2	0.47	0.39	0.42
Double, Low-e 4, 1/2+ argon	0.50	0.42	0.44
Double, Low-e 2, 1/2+ argon	0.46	0.37	0.40
Double, Low-e 1, 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-e 4, 1/4	0.50	0.40	0.40
Triple, Low-e 2, 1/4	0.48	0.39	0.41
Triple, Low-e 1, 1/4	0.47	0.38	0.40
Triple, Low-e 4, 1/4+ argon	0.46	0.37	0.39
Triple, Low-e 2, 1/4+ argon	0.43	0.34	0.37
Triple, Low-e 1, 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-e 4, 1/2	0.43	0.35	0.37
Triple, Low-e 2, 1/2	0.41	0.32	0.35
Triple, Low-e 1, 1/2	0.39	0.31	0.33
Triple, Low-e 4, 1/2 + argon	0.41	0.32	0.35
Triple, Low-e 2, 1/2+ argon	0.38	0.30	0.32
Triple, Low-e 1, 1/2 + argon	0.37	0.29	0.31

For SI: 1 inch = 25.4 mm.

- a. 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.
- b. Sunrooms/solariums may subtract 0.03 from the default U-factor.
- c. 1/4" = a minimum dead air space of 0.25 inch (6.4 mm) between the panes of glass.
3/8" = a minimum dead air space of 0.375 inch (9.5 mm) between the panes of glass.
1/2" = a minimum dead air space of 0.5 inch (12.7 mm) 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-factor, 5/16 inch = 1/4-inch U-factor.
- d. Low-e 4 (emissivity) shall be 0.4 or less.
Low-e 2 (emissivity) shall be 0.2 or less.
Low-e 1 (emissivity) shall be 0.1 or less.
- e. U-factors listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO², SF₆ and argon/SF₆ mixtures.
The following conversion factor shall apply to Krypton gas-filled units: 1/4-inch (6.4 mm) or greater airspace with Krypton gas fill = 1/2-inch (12.7 mm) airspace with Argon gas-fill.
- f. Dividers placed between glazing: The U-factors listed shall be used where the divider has a minimum gap of 1/8 inch (3.2 mm) between the divider and lite of each inside glass surface. Add 0.03 to the listed U-factor for True Divided Lite windows.
- g. "Glass block" assemblies may use a U-factor of 0.51.
- h. Insulated fiberglass framed products shall use wood/vinyl U-factors. (continued)
- i. Aluminum 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/h × ft² × °F;
 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-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.

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TABLE NF1114.3(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 ^l
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-e 4, 1/4	0.36	0.30	0.44	0.41
Double, Low-e 2, 1/4	0.35	0.29	0.43	0.40
Double, Low-e 1, 1/4	0.24	0.28	0.41	0.39
Double, Low-e 4, 1/4 + argon	0.33	0.28	0.41	0.39
Double, Low-e 2, 1/4 + argon	0.31	0.26	0.39	0.38
Double, Low-e 1, 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-e 4, 3/8	0.34	0.28	0.42	0.40
Double, Low-e 2, 3/8	0.33	0.28	0.41	0.39
Double, Low-e 1, 3/8	0.21	0.26	0.38	0.37
Double, Low-e 4, 3/8 + argon	0.32	0.27	0.40	0.38
Double, Low-e 2, 3/8 + argon	0.29	0.25	0.37	0.37
Double, Low-e 1, 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-e 4, 1/2	0.32	0.27	0.40	0.38
Double, Low-e 2, 1/2	0.30	0.26	0.38	0.37
Double, Low-e 1, 1/2	0.19	0.25	0.36	0.36
Double, Low-e 4, 1/2 + argon	0.30	0.26	0.38	0.37
Double, Low-e 2, 1/2 + argon	0.28	0.25	0.36	0.36
Double, Low-e 1, 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-e 4, 1/4	0.30	0.26	0.38	0.37
Triple, Low-e 2, 1/4	0.29	0.25	0.37	0.36
Triple, Low-e 4, 1/4 + argon	0.27	0.24	0.35	0.35
Triple, Low-e 2, 1/4 + argon	0.26	0.24	0.34	0.35

For SI: 1 inch = 25.4 mm.

- a. 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.
- b. 1/4" = a minimum dead air space of 0.25 inch (6.4 mm) between the panes of glass.
3/8" = a minimum dead air space of 0.375 inch (9.5 mm) between the panes of glass.
1/2" = a minimum dead air space of 0.5 inch (12.7 mm) 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-factor, 5/16 inch = 1/4-inch U-factor.
- c. Low-e 4 (emissivity) shall be 0.4 or less. Low-e 2 (emissivity) shall be 0.2 or less. Low-e 1 (emissivity) shall be 0.1 or less.
- d. U-factors listed for argon shall consist of sealed, gas-filled, insulated units for argon, CO₂, SF₆ and argon/SF₆ mixtures. The following conversion factor shall apply to Krypton gas-filled units: 1/4-inch or greater airspace with Krypton gas fill = 1/2 -inch airspace with Argon gas-fill.
- e. 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.
- 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/h/ft²/°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-factor 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-factor for half-lite values if the insulated door does not have a thermal break.

SECTION NF1115—THERMAL PERFORMANCE LABELING

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

NF1115.1 Labels. Labels shall be either:

1. National Fenestration Rating Council (NFRC) certified product; or
2. State-approved labels.

Labeling is not required for *glazing* not exceeding 1 percent of the *heated space floor area* and is exempt from Table N1104.1(1) thermal performance calculations.

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NF1115.2 Label description. All *windows* shall have state-approved labeling except as provided in Section NF1115.1, Item 1.

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.

NF1115.2.1 Windows produced in low volume labels. Labels for *windows produced in low volume* under Section NF1112.1, due to its frame and *glazing* configuration, shall comply with all of the following:

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 NF1112.1.
4. Imprint “[Manufacturer’s name] certifies the attached *window* is constructed in a manner to obtain the specified *U-factor*” or “[Manufacturer’s name] certifies the attached *skylight* complies with the criteria specified in the Oregon building codes.”
5. Be imprinted, not handwritten.
6. Face the interior of the room.
7. Remain attached to the *window* until the building inspector inspects and verifies the labeling.

NF1115.3 Labels for skylights exempted from thermal performance standards. Labels for *skylights* exempt from thermal performance standards under Section NF1114.2, Item 5, because of its frame and *glazing* configuration shall comply with all of the following:

1. Specify *skylight* 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 NF1112.1.
5. Imprint “[Manufacturer’s name] certifies the attached *skylight* complies with the criteria specified in the Oregon building codes.”
6. Contain the statement, “This skylight is not required to be tested or evaluated for thermal performance.”
7. State “EXEMPT” in 3/4-inch (20 mm) high letters.
8. Specify “Issued [date of issue].”
9. Contain the statement, “Under ORS 455.525(4), this skylight is deemed to comply with Oregon’s thermal performance standards regardless of *U-factor*.”

NF1115.4 Labels for sunrooms/solariums produced in low volume or exempted from testing. Labels for *solariums* and *sunrooms* produced in low volume or with 1/2-inch (12.7 mm) airspace between the *glazing* shall comply with all of the following:

1. Specify the 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 NF1112.
3. Show the *U-factor* determined by Section NF1114.2.1, Item 5 or Section NF1114.3, Item 4 for each of the glazed surfaces.
4. Imprint “[Manufacturer’s name] certifies the components of this *sunroom* or *solarium* are constructed in a manner to obtain the specified *U-factor*.”
5. Have one label providing a description of each of the glazed surfaces.

NF1115.5 Labels for skylights exempt from testing. Labels for *skylights* that are exempt from testing in accordance with Section NF1114.2, Item 4 shall comply with all of the following:

1. Specify *skylight* components.
2. State “Calculated *U-factor* Skylight Compliance Label.”
3. State *U-factor* determined by Section NF1114.2.1, Item 4.
4. Show a production count number that does not exceed the maximums established in Section NF1112.

NF1115.6 Combined products. Where different window types are combined, mullied together by the manufacturer or manufactured to fit a framed rough opening, a single label may be used.

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

NF1115.7 Label distribution. Labels provided under Section NF1114.2 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 NF1116—AIR LEAKAGE REQUIREMENTS

NF1116.1 General. *Windows* shall comply with the air leakage requirements of Section N1104.8.

Exception: Site-built windows.