

2007 OSSC ENVELOPE
Proposed changes shown
 (Commercial)

SECTION 1302
DEFINITIONS

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

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

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

BTU (British Thermal Unit). The amount of heat required to raise the temperature of 1 pound (0.454 kg) of water (about 1 pint) from 59°F to 60°F (15°C to 16°C).

BUILDING ENTRANCE. The building entrance is a door or set of doors used by the general public to both enter and exit the building. Emergency exit doors and security or secured doors are not considered a building entrance. A security or secured door is a door where a person needs a key, combination, card lock, or other security device to enter the building.

Comment [AS1]: This definition is needed for the new vestibule requirements.

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

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

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

COLD STORAGE SPACE. Spaces that are mechanically cooled and designed to be maintained at a temperature below 45°F (7°C) and at or above 28°F (-2.2°C).

Comment [m2]: Proposal #10-04

CONDITIONED SPACE A space within a building envelope, which is heated or cooled by an HVAC system, excluding Cold Storage Space and Frozen Storage Space (also see Semi-conditioned Space).

Comment [m3]: Proposal #10-04

CURTAINWALL. Fenestration used to create an external non load-bearing wall that is designed to separate exterior and interior environments.

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

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

EXTERIOR EXIT DOOR. A permanently installed operable exit by which an entry is closed and opened. ~~Exterior Exit doors include doors between separate~~ conditioned and unconditioned spaces. A sliding glass door is considered an exterior window.

Comment [AS4]: The term "exit" is used in nonresidential code. Exterior is now covered in Fenestration definition.

EXTERIOR ENVELOPE. See "Building Envelope."

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

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

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

FENESTRATION. ~~Windows and doors in the exterior envelope (see "Exterior door" and "Exterior window").~~ Vertical windows (fixed or operable), skylights, roof windows, opaque doors, glazed doors, glazed block, and combination opaque/glazed doors. Fenestration includes products with glass and non-glass/glazing materials.

Comment [AS5]: Update this definition – from 2006 IECC

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

FROZEN STORAGE SPACE. Spaces that are mechanically cooled and designed to be maintained at a temperature below 28°F (-2.2°C).

Comment [m6]: Proposal #10-04

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.~~

Comment [AS7]: Not necessary, covered under Fenestration

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

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

HEATED SPACE. A space within a building which is provided with a positive heat supply to maintain an air temperature of 55°F (13°C) or higher.

HEATED SPACE — OTHER BUILDINGS. A space within a building served by a mechanical, electrical or combustion source of heat. Spaces within a basement shall be defined

as heated when any of the following apply: the space is finished, has heating registers or contains heating devices.

K (Thermal Conductivity). See “Thermal conductivity.”

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

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

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

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

R (Thermal Resistance). See “Thermal resistance.”

REFRIGERATED WAREHOUSES. Buildings that contain cold storage spaces or frozen storage spaces that have total area exceeding 3,000 square feet.

Comment [m8]: Proposal #10-04

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

1. All group R occupancies three stories or less in height;
2. Group SR1, SR3 and SR4 and group I1 occupancies three stories or less in height. All SR-2 occupancies shall comply with other building requirements.

SC (SHADING COEFFICIENT). The ratio of solar heat gain through fenestration with or without integral shading devices to that occurring through unshaded $\frac{1}{8}$ -inch (3.2 mm) clear double strength glass.

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

Comment [m9]: Proposal #10-04

Climate Zone 1: 15 Btu/hr.ft.² (47 W/m²) or 4 Watts/ft.² (47 W/m²) of heated floor area.

Climate Zone 2: 20 Btu/hr.ft.² (63 W/m²) or 5.86 W/ft.² (63 W/m²) of heated floor area.

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

SKYLIGHT. Glazed fenestration that is mounted directly on the roof/ceiling assembly and separate conditioned or semi-conditioned spaces from unconditioned spaces.

Comment [AS10]: This should clearly delineate “skylight” as being directly on the roof – clerestories are not “skylight”

STOREFRONT (FENESTRATION). A nonresidential system of windows or windows and doors muller as a composite fenestration structure that has been designed to resist heavy use. Storefront systems include, but are not limited to, exterior fenestration systems that span from floor level or above, to the ceiling of the same story.

Comment [m11]: Modified from original proposal submitted

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

TERMAL BREAK FRAME (FENESTRATION). A non-metallic element of low heat conductivity placed in such a way as to eliminate all contact between interior and exterior framing members. Some metal-framed windows are designed with thermal breaks to improve their overall thermal performance.

Comment [AS12]: This is from the Oregon Non-Residential Code Compliance Manual.

THERMAL CONDUCTANCE (C). The constant time rate of heat flow through a unit area of a body induced by a unit temperature difference between the surfaces, Btu/(hr.-ft.²-°F). It is the reciprocal of thermal resistance. (See “Thermal resistance.”)

THERMAL CONDUCTIVITY (K). The rate of heat flow through 1 square foot of a homogeneous material 1 inch thick when there is a temperature difference of 1°F between the opposite faces of the material, expressed as Btu/hr. 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 (hr.-ft.²-°F)/Btu, and is the reciprocal of thermal conductance.

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

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

~~VAPOR BARRIER~~ ~~A film, duplex paper, aluminum foil or other material which restricts the movement of water vapor from an area of high vapor pressure to one of lower vapor pressure. See “Vapor Retarder.”~~

Comment [AS13]: Vapor barrier has been replaced with the term vapor retarder throughout this chapter.

VAPOR RETARDER A vapor resistant material, membrane or covering such as foil, plastic sheeting, or insulation facing having a permeance rating of 1 perm (5.7×10^{-11} kg/Pa • s • m²) or less when tested in accordance with the desiccant method using Procedure A of ASTM E 96. Vapor retarders limit the amount of moisture vapor that passes through a material or assembly.

Comment [AS14]: From 2006 IECC but “wall” is removed from assembly at end of section.

WINDOW. See “Exterior window.”

DIVISION III — OTHER BUILDINGS

SECTION 1311 OTHER BUILDINGS

1311.1 Alternate method of compliance using the whole building approach. Alternative building systems and equipment designs may be approved by the building official for other buildings. Applicants shall demonstrate that the whole building annual energy consumption will not exceed that used by a similar building using similar forms of energy designed in accordance

with the prescriptive requirements of this chapter. Compliance under this section allows trade-offs between the performance requirements in all sections of this chapter using 8,760-hour annual building simulation. The building official may require review of the simulation results by an independent reviewer.

1311.2. Optional compliance approach. All buildings, except occupancy group R, four stories and greater in height, with up to 40 percent window area (as a relationship to total exterior wall area) may demonstrate compliance with this approach by following the values in Table 1312.2(1) for Climate Zone 1 and Table 1312. (2) for Climate Zone 2. The mechanical system efficiency shall be from the Optional Efficiency column in Tables 1317.5.1(1), 1317.5.1(2), 1317.5.1(3), 1317.5.1(5), 1317.5.1(6), and 1317.5. (7). If a nonstandard condition, water-cooled, centrifugal chilling package that is not designed for operation at ARI Standard 550/590 test conditions is installed, the full load kW/ton rating and NPLV rating shall be 10 percent better than the required calculation. If packaged terminal units are installed, they shall be packaged terminal heat pumps.

Occupancy group R buildings, four stories and greater in height, with up to 40 percent window area (as a relationship to total exterior wall area) may demonstrate compliance with this approach by following the values in Table 1312.2(1) for Climate Zone 1 and Table 1312.2(2) for Climate Zone 2. The mechanical system efficiency shall be from the Optional Efficiency column in Tables 1317.5.1(1), 1317.5.1(2), 1317.5.1(3), 1317.5.1(5), 1317.5.1(6), and 1317.5.1(7). If a nonstandard condition, water-cooled, centrifugal chilling package that is not designed for operation at ARI Standard 550/590 test conditions is installed, the full load kW/ton rating and NPLV rating shall be 10 percent better than the required calculation. If packaged terminal units are installed, they shall be packaged terminal heat pumps. For HVAC systems not listed above, or HVAC does not provide conditioning for entire building, the lighting power density for dwelling units and guest rooms shall not exceed 0.7 watts per square foot of floor area.

1311.23 Documentation. The applicant shall submit documents showing compliance with the requirements of this chapter. This documentation shall be in a manner approved by the Administrator of the Building Codes Division.

SECTION 1312 EXTERIOR ENVELOPE — OTHER BUILDINGS

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

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

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

Exceptions:

1. Exterior wall insulation in semi-conditioned spaces (see definition in Section 1302).
2. Exterior wall insulation and doors in spaces enclosed in Group S, Division 3 Occupancies or Group H, Division 4 Occupancies, motor vehicle service station occupancies where each heating system is controlled by a thermostat with a maximum set point of 55°F (13°C).

3. Windows installed in demising walls need not meet the shading coefficient requirements of this section.
4. Buildings whose sole source of space conditioning energy is from on-site solar or wind resources.
5. Greenhouses intended primarily for plant propagation.

1312.32 Additions and alterations.

1312.32.1 Additions. Additions shall meet all requirements that apply to new buildings.

Exceptions:

1. Additions of the same use and occupancy classification as the existing building which increase floor area up to 10 percent of the existing building area, not to exceed 1,000 square feet (93 m²), if the component *U*-factors, including glazing, are equal to or less than corresponding *U*-factors in the existing building.
2. Additions which have glazing areas and/or skylight areas exceeding the maximum allowed under the prescriptive path and meet all the following requirements:
 - 2.1 The maximum height of the addition shall not exceed 20 feet (6.1 m) measured from the ground floor,
 - 2.2 The maximum floor area of the addition shall not exceed 3,000 square feet (279 m²) or 15 percent of the existing building ground floor area, whichever is less,
 - 2.3 The center-of-glass *U*-factor shall not exceed 0.30, tested or calculated in the vertical plane,
 - 2.4 The ~~shading~~ **solar heat gain** coefficient for overhead glazing shall not exceed ~~0.40~~**0.35**, the ~~shading~~ **solar heat gain** coefficient for vertical glazing shall not exceed ~~0.57~~**0.40**,
 - 2.5 At least 25 percent of the gross area of the exterior wall of the addition shall have a *U*-factor not to exceed ~~0.430~~**0.088** in Zone 1 and ~~0.090~~**0.075** in Zone 2, and
 - 2.6 Any opaque roof/ceiling portions shall have a *U*-factor not to exceed ~~0.050~~**0.048** or an insulation value not less than R-~~19~~**20 continuous insulation**.

1312.32.2 Alterations. Alterations to the building envelope shall meet the prescriptive requirements of the code. Exterior wall, roof and floor cavities opened or created during alteration shall be ventilated as required by Section 1203 and insulated as required by Tables ~~13-E~~**1312.3.1(1)** and ~~13-F~~**1312.3.1(2)** or to the full depth of the cavity, whichever is less.

Exceptions:

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

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

1312.23 Building envelope thermal performance. All heated or mechanically cooled buildings and structures, or portions thereof, shall be constructed so as to provide the required thermal performance of the various components as set forth in this subsection and 1312.4.

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

Buildings shall comply by using either Section 1312.3.1 or 1312.3.2. **Refrigerated Warehouses shall comply using Section 1312.2.3.**

1312.23.1 Prescriptive path approach. Buildings in Zone 1 shall meet the Prescriptive Path Approach if they comply with the values in Table 1312.3.1(1). Buildings in Zone 2 shall meet the Prescriptive Path Approach if they comply with the values in Table 1312.3.1(2). Each component (walls, roofs, etc.) shall meet either the U -factor standard for the assembly or the R -value standard for the insulation in the table.

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

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

1312.3.2 Simplified trade-off approach. Buildings may demonstrate compliance with the thermal performance standards of this section by using the Simplified Trade-off Approach (STA). The STA is an analytical method to determine if a proposed building has no larger annual heating load through the exterior envelope and no larger annual cooling load through the exterior envelope than a similar building meeting the Prescriptive Path Approach.

1312.2.3 Refrigerated Warehouse Approach. Exterior and interior surfaces of Frozen Storage Spaces or Cold Storage Spaces in refrigerated warehouses shall be insulated at least to the R-values in Table 1312.2.3(1). The remainder of refrigerated warehouse area containing conditioned or semi-conditioned spaces shall comply by using either Section 1312.2.1 or 1312.2.2.

Exception: Areas within refrigerated warehouses that are designed solely for the purpose of quick chilling or freezing of products with design cooling capacities of greater than 240 Btu/hr-ft² (2 tons per 100 ft²).

Comment [m15]: Proposal #10-04

Comment [AS16]: See new sections 1312.3.1 & 1312.3.4.1

Comment [m17]: Proposal #10-04

TABLE 1312.2.3(1) Refrigerated Warehouse Insulation

<u>SPACE</u>	<u>SURFACE</u>	<u>MINIMUM R-VALUE</u> (°F-hr-sf/Btu)
<u>Frozen Storage Spaces</u>	<u>Exterior Roof/Ceiling</u>	<u>R-36</u>
	<u>Exterior Wall</u>	<u>R-36</u>
	<u>Exterior Floor</u>	<u>R-36</u>
	<u>Interior Partition¹</u>	<u>R-28</u>
<u>Cold Storage Spaces</u>	<u>Exterior Roof/Ceiling</u>	<u>R-28</u>
	<u>Exterior Wall</u>	<u>R-28</u>
	<u>Interior Partition¹</u>	<u>R-19</u>

1. Interior partitions include any wall, floor, or ceiling that divides Frozen Storage Spaces or Cold Storage Spaces from each other, conditioned spaces, unconditioned spaces, or semi-conditioned spaces.

Comment [m18]: Proposal #10-04

**TABLE 13-E 1312.2.1 (1)
ENVELOPE PRESCRIPTIVE PATH, OTHER BUILDINGS – CLIMATE ZONE 1**

<u>COMPONENT¹</u>	<u>MAXIMUM CODE VALUE</u>		<u>MINIMUM ASSEMBLY</u>
Windows up to 30% glazing fraction ¹ Overall U-factor	<u>0.540U-0.46^d</u>	or	Fixed window: <u>Thermal break frame</u> , double-glazed with 0.5 inch airspace, low emissivity coating <u>≤0.20</u> . Curtainwall/Storefront ² or operable windows: <u>Thermal break frame</u> , double-glazed with 0.5 inch airspace, low emissivity coating, thermally broken frame <u>≤0.05</u> .
<u>Overall SHGC Shading Coefficient^{2,3,4}</u>	<u>0.57²SHGC-0.40^{3,4}</u>	or	Tinted outdoor pane
Windows up to 40% glazing fraction Overall U-factor	<u>0.370</u>	or	Fixed windows: Double-glazed with 0.5 inch airspace, argon-filled space, low emissivity coating not greater than 0.05, thermally broken frame. Curtainwall or operable windows: Triple-glazed with 0.5 inch airspace, low emissivity coating on two surfaces, thermally broken frame.
Shading Coefficient <u>Doors with glazing and exterior exit doors</u>	0.352 <u>U-0.850</u>	or	1/4" thick glass, low emissivity coating not greater than 0.05 tinted outdoor pane. <u>When doors contain glazing, it shall be double-glazed with 0.5 inch airspace, low emissivity coating not greater than 0.10.</u>
<u>Opaque sectional overhead doors⁵</u>	<u>U-0.200</u>		<u>R-5 insulation</u>
Skylights and glazed smoke vents ^{3,6} <u>Manufactured skylight U-factor</u>	1.230 <u>U-1.17</u>	or	<u>Thermal break frame</u> , double-glazed with 0.5 inch airspace, <u>low emissivity coating not greater than 0.05</u> .
<u>Site-assembled glazing U-factor</u>	<u>U-0.69</u>	or	<u>Double-glazed, 0.5 inch airspace, low emissivity coating not greater than 0.20.</u>
<u>Overall SHGC Shading Coefficient</u>	0.47 <u>SHGC-0.40^{2,3}</u>		N/A

Comment [AS21]: There's a catch22 with e=0.20. While e=0.40 will comply with U-0.50, most tints with e=0.40 will NOT comply with SHGC-0.40.

Comment [AS19]: This is the U for Min Assembly as described.

Comment [AS20]: 2005 ASHRAE Fundamentals no longer describes cog SC. Ch 31, Table13 provides default "overall SHGC" values for various frame & oper types. 0.40 SHGC is achievable with most tints on

Comment [AS22]: Addition of Storefront is a BIG change but ASHRAE & IECC categorize them this way

Comment [AS23]: 2005 ASHRAE Fundamentals no longer describes cog SC. Ch 31, Table13 provides default "overall SHGC" values for various frame & oper types. 0.40 SHGC is achievable with most tints on

Comment [AS24]: This 40% is based on an incremental improvement of 30%. Curtainwall/operable U is not readily obtainable. Real issue with higher % glazing is SC not U & CodeComp does this nicely.

Comment [AS25]: Here's the catch22 for meeting the ASHRAE U and SHGC standards: In order to "prescriptively" meet SHGC, a thermal break is necessary.

COMPONENT	MAXIMUM GLAZING FRACTION ¹	MAXIMUM COMPONENT U-FACTOR		MINIMUM INSULATION R-VALUE
Doors ⁴		0.200		
Floors, <u>over unconditioned spaces</u>		0.070 <u>0.034</u>	or	++ <u>30</u>
<u>Wood joist/framing</u>		<u>U-0.038</u>	or	<u>30</u>
<u>Steel framing ≥4' on-center, and other</u>		<u>U-0.083</u>	or	<u>7.59 c.i.⁷</u>
Heated slab edge <u>Concrete slab above-grade</u>				
<u>Concrete slab-on-grade</u>				
<u>Unheated slab</u>		<u>NR</u>	or	<u>NR</u>
<u>Heated slab</u>		<u>F-0.56</u>	or	<u>7.5</u>
Roofs ^{2,3}		0.050 <u>U-0.048</u>	or	19 <u>20 c.i.⁷</u> <u>13 + 13 + 5</u> <u>thermal blocks</u>
<u>Continuous insulation</u>		<u>U-0.055</u>	or	<u>38</u>
<u>Engineered metal building</u>		<u>U-0.035</u>	or	
<u>Attic, non-continuous and other</u>				
Walls ^{6,9}				
Masonry, with integral insulation ⁷	15%	0.300		
Masonry, with integral insulation ⁸	40%	0.210		
Masonry or concrete, with interior insulation- <u>steel frame</u>	40% <u>30%</u>	0.130 <u>U-0.083</u>	or	++ <u>13+4 c.i.⁷</u>
Masonry or concrete, with interior insulation- <u>wood frame</u>	40% <u>30%</u>	<u>U-0.083</u>	or	<u>15</u>
Masonry or concrete, with continuous exterior insulation	15%	0.300	or	1.4
Masonry or concrete, with continuous exterior insulation ¹⁰	40% <u>30%</u>	0.210 <u>U-0.104</u>	or	<u>2.85</u> <u>9.5 c.i.⁷</u>
Framed ¹¹	40%	0.130	or	1.3
<u>Wood</u>	<u>30%</u>	<u>U-0.083</u>	or	<u>15</u>
<u>Steel</u>	<u>30%</u>	<u>U-0.083</u>	or	<u>13+4 c.i.⁷</u>
<u>Engineered metal building</u>	<u>30%</u>	<u>U-0.084</u>	or	<u>19</u>
Other	40% <u>30%</u>	0.130 <u>U-0.088</u>	or	1.3 <u>10 c.i.⁷</u>
Below-grade walls		0.110 <u>C-0.146¹²</u>	or	<u>7.55 c.i.</u> <u>exterior⁷</u>

Comment [AS26]: 2x10 wood joist 16" oc R-30 @ R-26.07, 1/2" plywood, cork tile, 15 mph moving air @ 0.17 & still air @ R-0.92

Comment [AS27]: 4" concrete @ R-0.75, 7.5 moving air @ R-0.25, still air @ R-0.92, cork tile & R-10 cont insul

Comment [AS28]: No change from current code

Comment [AS29]: U-0.055 from 90.1-07 Addenda, R-13+R-13+R-5 thermal block

Comment [AS30]: R-38 from ASHRAE, Metal truss (Table A9.2A) R-38 @ R-28.12, 15 mph moving air @ 0.17 & still air @ R-0.61

Comment [AS31]: 6" hw concrete @ R-0.2, R-5 cont insul, 15 mph moving air @ 0.17 & still air @ R-0.68

For SI: 1 inch = 25.4 mm.

¹ Percent glazing fraction for windows is based on total exterior window area divided by the total exterior wall area including demising walls. Percent area for skylights is based on total skylight and glazed smoke vent rough frame area divided by the total roof area. Glazing limit depends on the overall U-factor of the window assembly.

² The shading coefficient is a center-of-glass value. Windows and doors that are contained within an unconditioned vestibule are exempt from U-factor and solar heat gain coefficient requirements.

³ Maximum skylight area = 6 percent of total roof area. The solar heat gain coefficient is an overall value of the fenestration assembly.

⁴ The U-factor is a center of panel U-factor. The following doors are exempt from door and window U-factor and shading coefficient requirements: (1) Entry/Exit doors with a leaf width of 4 feet (1.2 m) or less, and (2) overhead coil doors. Street-level windows for retail display or compliance with local planning ordinance are exempt from solar heat gain coefficient requirements.

- 5 Opaque smoke vents are exempt from U-factor requirements. The U-factor is a center of panel U-factor. Overhead coil doors are exempt from U-factor requirements.
- 36 Minimum weight of masonry and concrete walls = 45 lbs./ft² (220 kg/m²) of wall face area. Maximum skylight area = 5 percent of total roof area. Manufactured skylights are installed on an insulated curb. Site-assembled glazing is integrated into the roof assembly and not on installed on a curb.
- 7 All cores to be filled. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation. Continuous insulation (c.i.) is insulation applied so the R-value specified is uncompressed and uninterrupted by framing across the entire surface.
- 8 All cores except bond beams must contain rigid insulation inserts approved for use in reinforced masonry walls. Opaque smoke vents are exempt from U-factor requirements.
- 9 Batt insulation installed in metal or wood framed walls shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth. The exterior perimeter of all above grade floors shall be insulated to the same value as the exterior wall above that floor.
- 10 Minimum weight of masonry and concrete walls = for this category shall be at least 45 lbs./ft² (220 kg/m²) of wall face area.
- 11 Batt insulation installed in metal or wood framed walls with continuous exterior insulation shall be installed in substantial contact with exterior sheathing. Batt insulation installed in metal or wood framed walls without continuous exterior insulation shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth.
- 12 A C-factor of 0.146 can be achieved with an assembly that is 2x4 steel framed with R-13 batt insulation.

TABLE 13-F1312.3.1 (2)
ENVELOPE PRESCRIPTIVE PATH, OTHER BUILDINGS – CLIMATE ZONE 2

COMPONENT ¹	MAXIMUM CODE VALUE		MINIMUM ASSEMBLY
Windows up to 25% glazing fraction ¹ Overall U-factor	0.540 U-0.460	or	Fixed window: Thermal break frame , double-glazed with 0.5 inch airspace, low emissivity coating ≤0.20. Curtainwall/ Storefront or operable windows: Thermal break frame , double-glazed with 0.5 inch airspace, low emissivity coating ≤0.05.
Overall SHGC Shading Coefficient ^{2,3,4}	0.570 SHGC-0.40 ^{3,4}	or	Tinted outdoor pane
Windows up to 33% glazing fraction Overall U-factor	0.370	or	Fixed windows: Double-glazed with 0.5 inch airspace, argon filled space, low emissivity coating not greater than 0.05, thermally broken frame Curtainwall or operable windows: Project shall only use Maximum Code Value.
Shading Coefficient Doors with glazing and exterior exit doors	0.43 ² U-0.85	or	1/4" thick glass, low emissivity coating not greater than 0.05 tinted outdoor pane. When doors contain glazing, it shall be double-glazed with 0.5 inch airspace, low emissivity coating not greater than 0.10.
Opaque sectional overhead doors ⁵	U-0.200		R-5 insulation
Skylights and glazed smoke vents ³⁶ Manufactured skylight U-factor Site-assembled glazing U-factor	1.230 U-1.10 U-0.69	or	Thermal break frame , double-glazed with 0.5 inch airspace, low emissivity coating not greater than 0.05, Double-glazed, 0.5 inch airspace, low emissivity coating not greater than 0.20.
Overall SHGC Shading Coefficient ^{3,3}	0.47 SHGC-.40 ^{3,3}		N/A

- Comment [AS32]:** This is the U for Min Assembly as described.
- Comment [AS33]:** Addition of Storefront is a BIG change but ASHRAE & IECC categorize them this way
- Comment [AS34]:** 2005 ASHRAE Fundamentals no longer describes cog SC. Ch 31, Table13 provides default "overall SHGC" values for various frame & oper types. 0.40 SHGC is achievable with most tints on
- Comment [AS35]:** This 33% is based on an incremental improvement of 30%. Curtainwall/operable U is not readily obtainable. Real issue with higher % glazing is SC not U & CodeComp does this nicely.
- Comment [AS36]:** Here's the catch22 for meeting the ASHRAE U and SHGC standards: In order to "prescriptively" meet SHGC, a thermal break is necessary.

COMPONENT	MAXIMUM GLAZING FRACTION ¹	MAXIMUM COMPONENT U-FACTOR		MINIMUM INSULATION R-VALUE
Doors ⁴		0.200		
Floors, <u>over unconditioned spaces</u>				
<u>Wood joist framing</u>		0.070 U-0.034	or	11 30
<u>Steel framing ≥4' on-center, and other</u>		U-0.038	or	30
Heated slab edge <u>Concrete slab above-grade</u>		U-0.076	or	7.5 10 c.i. ⁷
<u>Concrete slab-on-grade</u>				
<u>Unheated slab</u>		NR	or	NR
<u>Heated slab</u>		F-0.56	or	7.5
Roofs ^{5,8}				
<u>Continuous insulation</u>		0.050 U-0.048	or	19 20 c.i. ⁷
<u>Engineered metal building</u>		U-0.055	or	13 + 13 + 5 thermal blocks
<u>Attic, non-continuous and other</u>		U-0.035	or	38
Walls ^{6,2}				
Masonry, with integral insulation ⁷	15%	0.300		
Masonry, with integral insulation ⁸	33%	0.160		
Masonry or concrete, with interior insulation- <u>steel frame</u>	33% 30%	0.090 U-0.069	or	13 21+5 c.i. ⁷
Masonry or concrete, with interior insulation- <u>wood frame</u>	30%	U-0.063		21
Masonry or concrete, with continuous exterior insulation	15%	0.270	or	1.4
Masonry or concrete, with continuous exterior insulation ¹⁰	33% 30%	0.160 U-0.090	or	2.8 11.4 c.i. ⁷
Frame ^{9,11}	33%	0.090	or	13
<u>Wood</u>	30%	U-0.063	or	19 21
<u>Steel</u>	30%	U-0.069	or	21+5 c.i. ⁷
<u>Engineered metal building</u>	30%	U-0.072	or	13+R-5 c.i. ⁷
Other	33% 30%	0.090 U-0.075	or	13 12 c.i. ⁷
Below-grade walls		0.110 C-0.110 ¹²	or	7.5 c.i. exterior ⁷

Comment [AS37]: 2x10 wood joist 16" oc R-30 @ R-26.07, 1/2" plywood, cork tile, 15 mph moving air @ 0.17 & still air @ R-0.92

Comment [AS38]: 2x10 wood joist 16" oc R-30 @ R-26.07, 1/2" plywood, cork tile, 15 mph moving air @ 0.17 & still air @ R-0.92

Comment [AS39]: 4" concrete @ R-0.75, 7.5 moving air @ R-0.25, still air @ R-0.92, cork tile & R-10 cont insul

Comment [AS40]: No change from current code

Comment [AS41]: U-0.055 from 90.1-07 Addenda, R-13+R-13+R-5 thermal block

Comment [AS42]: R-38 from ASHRAE, Metal truss (Table A9.2A) R-38 @ R-28.12, 15 mph moving air @ 0.17 & still air @ R-0.61

Comment [AS43]: 6" hw concrete @ R-0.2, R-5 cont insul, 15 mph moving air @ 0.17 & still air @ R-0.68

Comment [AS44]: 2x4 16" oc @ R-6, R-5 cont insul, 1/2" plywd siding/shrng @ R-0.62, 1/2" gyp wallbrd @ R-0.45, 15 mph moving air @ 0.17 & still air @ R-0.68

Comment [AS45]: Extrapolated from new Table 1312.3.4.4.2

For SI: 1 inch = 25.4 mm.

¹ Percent glazing fraction for windows is based on total exterior window area divided by the total exterior wall area including demising walls. Percent area for skylights is based on total skylight and glazed smoke vent rough frame area divided by the total roof area. Glazing limit depends on the overall U-factor of the window assembly.

² The shading coefficient is a center of glass value. Windows and doors that are contained within an unconditioned vestibule are exempt from U-factor and solar heat gain coefficient requirements.

³ Maximum skylight area = 6 percent of total roof area. The solar heat gain coefficient is an overall value of the fenestration assembly.

⁴ The U-factor is a center of panel U-factor. The following doors are exempt from door and window U-factor and shading coefficient requirements: (1) Entry/Exit doors with a leaf width of 4 feet (1.2 m) or less, and (2) overhead coil doors. Street-level windows for retail display or compliance with local planning ordinance are exempt from solar heat gain coefficient requirements.

⁵ Opaque smoke vents are exempt from U-factor requirements. The U-factor is a center of panel U-factor. Overhead coil doors are exempt from U-factor requirements.

- ²⁶ Minimum weight of masonry and concrete walls = 45 lbs./ft² (220 kg/m²) of wall face area. Maximum skylight area = 5 percent of total roof area. Manufactured skylights are installed on an insulated curb. Site-assembled glazing is integrated into the roof assembly and not on installed on a curb.
- ⁷ All cores to be filled. At least 50 percent of cores must be filled with vermiculite or equivalent fill insulation. Continuous insulation (c.i.) is insulation applied so the R-value specified is uncompressed and uninterrupted by framing across the entire surface.
- ⁸ All cores except bond beams must contain rigid insulation inserts approved for use in reinforced masonry walls. Opaque smoke vents are exempt from U-factor requirements.
- ² Batt insulation installed in metal or wood framed walls shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth. The exterior perimeter of all above grade floors shall be insulated to the same value as the exterior wall above that floor.
- ¹⁰ Minimum weight of masonry and concrete walls = for this category shall be at least 45 lbs./ft² (220 kg/m²) of wall face area.
- ¹¹ Batt insulation installed in metal or wood framed walls with continuous exterior insulation shall be installed in substantial contact with exterior sheathing. Batt insulation installed in metal or wood framed walls without continuous exterior insulation shall be insulated to the full depth of the cavity, up to 6 inches (150 mm) in depth.
- ¹² A C-factor of 0.110 can be achieved with an assembly that is 2x4 steel framed with R-13 batt insulation.

1312.4.2 Insulation materials and installation. All insulation materials shall be installed according to the manufacturer’s instructions to achieve proper densities, maintain clearances and maintain uniform R-values. Access to equipment shall be provided which prevents damaging or compressing the insulation. Refer to Section 1312.2 for performance requirements.

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

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

Table 1312.4 shall be used for fiberglass batt insulation R-values that are installed in cavities smaller than its nominal thickness.

Comment [AS46]: Redundant language

Comment [AS47]: From ASHRAE 90.1-2007

TABLE 1312.4 EFFECTIVE R-VALUES FOR FIBERGLASS BATT

Insulation R-Value at Standard Thickness									
Rated R-Value		38	30	22	21	19	15	13	11
Standard Thickness		12	9.5	6.5	5.5	6	3.5	3.5	3.5
Nominal Lumber Size, in.	Actual Depth of Cavity, in.	Effective Insulation R-Values when Installed in a Confined Cavity							
2 x 12	11.25	37	–	–	–	–	–	–	–
2 x 10	9.25	32	30	–	–	–	–	–	–
2 x 8	7.25	27	26	22	21	19	–	–	–
2 x 6	5.5	–	21	20	21	18	–	–	–
2 x 4	3.5	–	–	14	–	13	15	13	11
–	2.5	–	–	–	–	–	–	9.8	–
–	1.5	–	–	–	–	–	–	6.3	6

1312.4.1 Roof assemblies. All roofs shall comply with the insulation R-value or equivalent U-factors as specified in Tables 1312.2.1 (1) or 1312.2.1 (2). Skylight curbs shall be insulated to the same insulation level as the continuous insulation on the roof deck or R-10, whichever is less.

Comment [AS48]: OR amendment to clarify that curbs shall be insulated.

Exception. Continuous roof deck insulation (c.i). Where thickness of insulation varies, such as sloped insulation for water drainage, a weighted *U*-factor is equivalent to that *U*-factor specified. Whenever a weighted *U*-factor is calculated, minimum thickness of insulation shall not be less than R-10.

Comment [AS49]: Oregon amendment to clarify how to deal with sloped insulation

1312.4.1.1 Engineered metal building roofs. For the purpose of section 1312.2, base assembly is a *roof* where batt insulation is draped over the steel structure (purlins) and then compressed when the metal roof panels are attached to the steel structure (purlins). Additional assemblies include *continuous insulation* that is uncompressed and uninterrupted by framing. Overall assembly *U*-factors for engineered metal building shall be as specified in Table 1312.4.1.1.

Comment [AS50]: From ASHRAE 90.1-2007

**TABLE 1312.4.1.1
ASSEMBLY U-FACTORS FOR ENGINEERED METAL BUILDING ROOFS**

Comment [AS51]: From ASHRAE Standard 90.1-07, Addendum g

INSULATION SYSTEM	RATED R-VALUE OF INSULATION	TOTAL RATED R-VALUE OF INSULATION	OVERALL U-FACTOR FOR ENTIRE BASE ROOF ASSEMBLY	OVERALL U-FACTOR FOR ASSEMBLY OF BASE ROOF PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)					
				R-5.6	R-11.2	R-16.8	R-22.4	R-28	R-33.6
Standing Seam Roofs with R-3.5 (min) Thermal Spacer Blocks									
Single Layer	None	0	U-1.280	0.157	0.083	0.057	0.043	0.035	0.029
	R-6	6	U-0.167	0.086	0.058	0.044	0.035	0.029	0.025
	R-10	10	U-0.097	0.063	0.046	0.037	0.031	0.026	0.023
	R-11	11	U-0.092	0.061	0.045	0.036	0.030	0.026	0.022
	R-13	11	U-0.083	0.057	0.043	0.035	0.029	0.025	0.022
	R-16	16	U-0.072	0.051	0.040	0.033	0.028	0.024	0.021
	R-19	19	U-0.065	0.048	0.038	0.031	0.026	0.023	0.020
Double Layer	R-10 + R-10	20	U-0.063	0.047	0.037	0.031	0.026	0.023	0.020
	R-10 + R-11	21	U-0.061	0.045	0.036	0.030	0.026	0.023	0.020
	R-11 + R-11	22	U-0.060	0.045	0.036	0.030	0.026	0.022	0.020
	R-10 + R-13	23	U-0.058	0.044	0.035	0.029	0.025	0.022	0.020
	R-11 + R-13	24	U-0.057	0.043	0.035	0.029	0.025	0.022	0.020
	R-13 + R-13	26	U-0.055	0.042	0.034	0.029	0.025	0.022	0.019
	R-10 + R-19	29	U-0.052	0.040	0.033	0.028	0.024	0.021	0.019
	R-11 + R-19	30	U-0.051	0.040	0.032	0.027	0.024	0.021	0.019
	R-13 + R-19	32	U-0.049	0.038	0.032	0.027	0.023	0.021	0.019
R-16 + R-19	35	U-0.047	0.037	0.031	0.026	0.023	0.020	0.018	
R-19 + R-19	38	U-0.046	0.037	0.030	0.026	0.023	0.020	0.018	
Liner System	R-11 + R-19	30	U-0.035	N/A	N/A	N/A	N/A	N/A	N/A
	R-11 + R-25	36	U-0.031	N/A	N/A	N/A	N/A	N/A	N/A
	R-11 + R-30	41	U-0.029	N/A	N/A	N/A	N/A	N/A	N/A
	R-11 + R-11 + R-25	47	U-0.026	N/A	N/A	N/A	N/A	N/A	N/A
Standing Seam Roofs without Thermal Spacer Blocks									
Liner System	R-11 + R-19	30	U-0.040	N/A	N/A	N/A	N/A	N/A	N/A
Filled Cavity with R-3.5 (min) Thermal Spacer Blocks									
	R-11 + R-10	29	U-0.041	0.033	0.028	0.024	0.021	0.020	0.017
(Multiple R-values are listed in order from inside to outside)									
Thru-Fastened without Thermal Spacer Blocks									
	R-10	10	U-0.153	N/A	N/A	N/A	N/A	N/A	N/A
	R-11	11	U-0.139	N/A	N/A	N/A	N/A	N/A	N/A
	R-13	13	U-0.130	N/A	N/A	N/A	N/A	N/A	N/A
	R-16	16	U-0.106	N/A	N/A	N/A	N/A	N/A	N/A
	R-19	19	U-0.098	N/A	N/A	N/A	N/A	N/A	N/A
Liner System	R-11 + R-19	30	U-0.044	N/A	N/A	N/A	N/A	N/A	N/A

1312.4.1.1.1 Rated R-value of insulation

1312.4.1.1.1.1 The first *rated R-value of insulation* is for insulation draped over purlins and then compressed when the metal roof panels are attached, or for insulation hung between the purlins. A minimum R-3.5 thermal spacer block between the purlins and metal roof panel is required as specified in Tables 1312.2.1 (1) and 1312.2.1 (2).

1312.4.1.1.1.2 For double-layer installations, the second *rated R-value of insulation* is for insulation installed parallel to purlins.

1312.4.1.1.1.3 For continuous insulation (e.g., insulation board or blankets) it is assumed that insulation is installed below the purlins and is uninterrupted by framing members. Insulation exposed to the *conditioned space* shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.

1312.4.1.1.1.4 Liner system (Ls). A continuous vapor retarder liner is installed below the purlins and uninterrupted by framing members. Uncompressed, unfaced insulation rests on top of the liner between the purlins. For multilayer installations, the *first rated R-value of insulation* is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached. A minimum R-3.5 thermal spacer block between the purlins and the metal roof panels is required when specified in Table 1312.4.1.1.

1312.4.2 Suspended ceilings with removable ceiling tiles shall not be considered part of the ~~minimum thermal resistance of ceiling or roof insulation used to separate conditioned spaces from unconditioned spaces.~~

1312.4.4 Wall insulation.

1312.4.4.1 Above-grade wall insulation. All above-grade walls shall comply with the insulation R-value or equivalent U-factors as specified in Tables 1312.2.1(1) or 1312.2.1(2). Where multiple thicknesses of rigid insulation is used for exterior *continuous insulation* (c.i.), a weighted U-factor is equivalent to that U-factor specified.

Where *continuous insulation* is used in exterior walls, metal suspension, subframing systems for exterior cladding shall not exceed 14 percent of exterior wall stud surface area.

Example of acceptable vertical metal standoff area for metal subframing:

189" (10' stud height) * 1.75" (stud width) = 210 in² stud surface area

1 bracket * 6.3" high * 2" wide = 12.6 in²

2 brackets * 3.15" high * 2" wide = 12.6 in²

(12.6 + 12.6) / 210 = 13 percent of exterior wall stud

1312.4.4.2 Steel framed walls. For the purpose of this section, base assembly is a wall where insulation is installed within the cavity of steel stud framing but where there is not a metal exterior surface spanning member. Steel stud framing is a minimum uncoated thickness of 0.043 inch for 18-gauge or 0.054 inch for 16-gauge. The U-factors include R-0.17 for an

Comment [AS52]: From ASHRAE Standard 90.1-07, Addendum g

Comment [AS53]: OR amendment to clarify code application of different types of construction

Comment [AS54]: This will require a thermally-improved metal subframing cladding system when c.i. insulation is used.

Comment [AS55]: From ASHRAE 90.1-2007

exterior air film, R-0.08 for stucco, R-0.56 for 0.625 inch (16mm) gypsum board on exterior, R-0.56 for 0.625 inch (16mm) gypsum board on interior, and 0.68 for interior vertical still-air surface film. The performance of insulation/framing layer is calculated using values from Table 1312.4.4.2. Additional assemblies include *continuous insulation*, uncompressed and uninterrupted by framing. *U*-factors are provided for the following configurations:

- (1) *Standard framing*: steel stud framing at 16 in on center with cavities filled with 16 in. wide (full-width) insulation for both 3.5 and 6.0 inch deep wall cavities.
- (2) *Advanced framing*: steel stud framing at 24 in on center with cavities filled with 24 in. wide (full-width) insulation for both 3.5 and 6.0 inch deep wall cavities.

TABLE 1312.4.4.2 EFFECTIVE INSULATION/FRAMING LAYER R-VALUES FOR WALL INSULATION INSTALLED BETWEEN STEEL FRAMING

NOMINAL CAVITY DEPTH, INCHES	ACTUAL CAVITY DEPTH, INCHES	RATED R-VALUE OF AIRSPACE OR INSULATION	EFFECTIVE FRAMING/CAVITY R-VALUE @ 16" ON CENTER	EFFECTIVE FRAMING/CAVITY R-VALUE @ 24" ON CENTER
Empty Cavity, No Insulation				
4	3.5	R-0.91	0.79	0.91
Insulated Cavity				
4	3.5	R-11	5.5	6.6
4	3.5	R-13	6.0	7.2
4	3.5	R-15	6.4	7.8
6	6	R-19	7.1	8.6
6	6	R-21	7.4	9.0
6	6	R-25	7.8	9.6

1312.4.4.2.1 Rated R-Value of Insulation for Steel-Framed Walls

1312.4.4.2.1.1 The first *rated R-value of insulation* is for uncompressed insulation installed in the cavity between steel studs. It is acceptable for this insulation to also be *continuous insulation* uninterrupted by framing.

1312.4.4.2.1.2 If there are two values, the second *rated R-value of insulation* is for continuous insulation uninterrupted by framing, etc., to be installed in addition to the first insulation.

1312.4.4.2.1.3 Opaque mullions in spandrel glass shall be covered with insulation complying with the steel-framed wall requirements.

1312.4.4.2.2 U-Factors for Steel-Framed Walls

1312.4.4.2.2.1 *U*-factors for steel-framed walls shall be taken from Table 1312.4.4.2.2.

1312.4.4.2.2.2 For *steel-framed walls* with framing at less than 24 in. on center, use the standard framing values as described in Section 1312.4.4.2. (a).

1312.4.4.2.2.3 For *steel-framed walls* with framing from 24 to 32 in. on center, use the advanced framing values as described in Section 1312.4.4.2 (b).

1312.4.4.2.4 For *steel-framed walls* with framing greater than 32 in. on center, use the *engineered metal building wall* values in Table 1312.4.4.2.

**TABLE 1312.4.4.2
ASSEMBLY U-FACTORS FOR STEEL-FRAME WALLS**

FRAMING TYPE & SPACING WIDTH (ACTUAL DEPTH)	CAVITY INSULATION R-VALUE: RATED (EFFECTIVE INSTALLED)	OVERALL U-FACTOR FOR ENTIRE BASE WALL ASSEMBLY	OVERALL U-FACTOR FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)																			
			RATED R-VALUE OF CONTINUOUS INSULATION																			
			R-1.0	R-2.0	R-3.0	R-4.0	R-5.0	R-6.0	R-7.0	R-8.0	R-9.0	R-10.0	R-11.0	R-12.0	R-13.0	R-14.0	R-15.0	R-20.0	R-25.0	R-30.0	R-35.0	R-40.0
Steel Framing at 16 in. on center																						
3.5 in. depth	None (0.0)	U-0.352	0.260	0.207	0.171	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
	R-11 (5.5)	U-0.132	0.117	0.105	0.095	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.046	0.044	0.036	0.031	0.027	0.024	0.021
	R-13 (6.0)	U-0.124	0.111	0.100	0.091	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.045	0.043	0.036	0.030	0.026	0.023	0.021
	R-15 (6.4)	U-0.118	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.035	0.030	0.026	0.023	0.021
6 in. depth	19 (7.1)	U-0.109	0.099	0.090	0.082	0.076	0.071	0.066	0.062	0.058	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.034	0.029	0.026	0.023	0.020
	21 (7.4)	U-0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.022	0.020
Steel Framing at 24 in. on center																						
3.5 in. depth	None (0.0)	U-0.338	0.253	0.202	0.168	0.144	0.126	0.112	0.100	0.091	0.084	0.077	0.072	0.067	0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
	R-11 (6.6)	U-0.116	0.104	0.094	0.086	0.079	0.073	0.068	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.035	0.030	0.026	0.023	0.021
	R-13 (7.2)	U-0.108	0.098	0.089	0.082	0.075	0.070	0.066	0.062	0.058	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.023	0.020
	R-15 (7.8)	U-0.102	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.056	0.053	0.050	0.048	0.046	0.044	0.042	0.040	0.034	0.029	0.025	0.022	0.020
6 in. depth	19 (8.6)	U-0.057	0.086	0.079	0.073	0.068	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.041	0.039	0.033	0.028	0.025	0.022	0.020
	21 (9.0)	U-0.048	0.073	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.045	0.043	0.042	0.040	0.038	0.032	0.028	0.024	0.022	0.020

1312.4.4.3 Wood framed walls. The base assembly wall is a wall where the insulation is installed between 2-inch nominal wood framing. Cavity insulation is full depth, but values are taken from Table 1312.3 for R-19 insulation, which is compressed when installed in a 5.5 inch cavity. Headers are double 2-inch nominal wood framing. The U-factors include R-0.17 for exterior air film, R-0.08 for stucco, R-0.56 for 0.625 inch gypsum board on exterior, R-0.56 for 0.625 inch gypsum board on interior, and R-0.68 for interior air film, vertical surfaces. Additional assemblies include *continuous insulation*, uncompressed and uninterrupted by framing. U-factors are provided for the following configurations:

Comment [AS56]: From ASHRAE 90.1-2007

- (1) *Standard framing:* wood framing at 16-inch on center with cavities filled with 14.5-inch wide insulation for both 3.5-inch and 5.5-inch deep wall cavities. Double headers leave no cavity. Weighing factors are 75% insulated cavity, 21% studs, plates and sills, and 4% headers.
- (2) *Advanced framing:* wood framing at 24-inch on center with cavities filled with 22.5-inch wide insulation for both 3.5 inch deep and 5.5-inch deep wall cavities. Double

headers have uninsulated cavities. Weighing factor are 78% insulated cavity, 18% studs plates and sills, and 4% headers.

- (3) Advanced framing with insulated headers: wood framing at 24-inch on center with cavities filled with 22.5-inch wide insulation for both 3.5 inch deep and 5.5-inch deep wall cavities. Double headers have uninsulated cavities. Weighing factor are 78% insulated cavity, 18% studs plates and sills, and 4% headers.

1312.4.4.3.1 Rated R-value of insulation for wood framed walls

1312.4.4.3.1.1. The first rated R-value of insulation is for uncompressed insulation installed in the cavity between wood studs. It is acceptable for this insulation to also be continuous insulation uninterrupted by framing.

1312.4.4.3.1.2. If there are two R-values, the second rated R-value of insulation is for continuous insulation uninterrupted by framing, etc., to be installed in addition to the first insulation.

1312.4.4.3.2 U-factors for wood-framed walls

1312.4.4.3.2.1. U-factors for wood-framed walls shall be take from Table 1312.4.4.3.2.

1312.4.4.3.2.2. For wood-framed walls with framing at less than 24 inches on center, use the standard framing values as described in 1312.4.4.3 (1) when Table 1312.4.4.3.2 is not used.

1312.3.4.3.2.3. For wood-framed walls with framing from 24 to 32 inches on center, use the advanced framing values as described in 1312.4.4.3 (2) if headers are uninsulated or the advanced framing with insulated headers as described in 1312.4.4.3 (3) when Table 1312.4.4.3.2 is not used.

1312.4.4.3.2.4. For wood-framed walls with framing greater than 32 inches on center, U-factors shall either be determined using parallel path calculation method or tested in accordance to ASTM C-1363-05.

**TABLE 1312.4.4.3.2
ASSEMBLY U-FACTORS FOR WOOD-FRAME WALLS**

FRAMING TYPE & SPACING WIDTH (ACTUAL DEPTH)	CAVITY INSULATION R-VALUE: RATED (EFFECTIVE INSTALLED)	OVERALL U-FACTOR FOR ENTIRE BASE WALL ASSEMBLY	OVERALL U-FACTOR FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)																			
			RATED R-VALUE OF CONTINUOUS INSULATION																			
			R-1.0	R-2.0	R-3.0	R-4.0	R-5.0	R-6.0	R-7.0	R-8.0	R-9.0	R-10.0	R-11.0	R-12.0	R-13.0	R-14.0	R-15.0	R-20.0	R-25.0	R-30.0	R-35.0	R-40.0
Wood Studs at 16 in. on center																						
3.5 in. depth	None (0.0)	U-0.292	0.223	0.181	0.152	0.132	0.116	0.104	0.094	0.086	0.079	0.073	0.068	0.064	0.060	0.056	0.053	0.042	0.035	0.030	0.026	0.023
	R-11 (11.0)	U-0.096	0.087	0.079	0.073	0.068	0.063	0.059	0.056	0.053	0.050	0.048	0.046	0.044	0.042	0.040	0.038	0.032	0.028	0.024	0.022	0.020
	R-13 (13.0)	U-0.089	0.080	0.074	0.068	0.063	0.059	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.040	0.038	0.037	0.031	0.027	0.024	0.021	0.019
5.5 in. depth	R-15 (15.0)	U-0.083	0.075	0.069	0.064	0.061	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.030	0.026	0.023	0.020	0.019
	19 (18)	U-0.067	0.062	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021	0.019	0.018
	21 (21)	U-0.063	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.031	0.030	0.026	0.023	0.021	0.019	0.017
+ R-10 headers	19 (18)	U-0.063	0.059	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.031	0.027	0.024	0.021	0.019	0.017
	21 (21)	U-0.059	0.055	0.051	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020	0.018	0.017
Wood Studs at 24 in. on center																						

3.5 in. depth	None (0.0)	U-0.298	0.227	0.183	0.154	0.133	0.117	0.105	0.095	0.086	0.079	0.074	0.068	0.064	0.060	0.057	0.054	0.042	0.035	0.030	0.026	0.023
	R-11 (11.0)	U-0.094	0.085	0.078	0.072	0.067	0.062	0.059	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.040	0.038	0.032	0.027	0.024	0.022	0.019
	R-13 (13.0)	U-0.086	0.078	0.072	0.067	0.062	0.058	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.031	0.026	0.023	0.021	0.019
	R-15 (15.0)	U-0.080	0.073	0.067	0.062	0.058	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.035	0.029	0.026	0.023	0.020	0.018
5.5 in. depth	19 (18)	U-0.065	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.032	0.027	0.024	0.021	0.019	0.018
	21 (21)	U-0.060	0.056	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020	0.018	0.017
+ R-10 headers	19 (18)	0.062	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.027	0.024	0.021	0.019	0.017
	21 (21)	0.057	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.023	0.020	0.018	0.017

Comment [AS57]: From ASHRAE 90.1-2007

1312.4.4.4 Engineered metal building walls. The base assembly is a wall where the insulation is compressed between metal wall panels and the metal structure. Additional assemblies include continuous insulation, uncompressed and uninterrupted by framing.

1312.4.4.4.1 Rated R-value of insulation for engineered metal building walls

1312.4.4.4.1.1 The first rated R-value of insulation is for insulation compressed between metal wall panels and the steel structure.

1312.4.4.4.1.2 For double-layer installations, the second rated R-value of insulation is for insulation installed from the inside, covering the girts.

1312.4.4.4.1.3 For continuous insulation (e.g., insulation boards) it is assumed the insulation is installed on the inside of the girts and uninterrupted by the framing members.

1312.4.4.4.1.4 Insulation exposed to the conditioned space shall have a facing, and all insulation seams shall be continuously sealed to provide a continuous air barrier.

1312.4.4.4.2 U-factors for engineered metal building walls. U-factors for engineered metal building walls shall be taken from Table 1312.4.4.4.2. It is not acceptable to use these U-factors if additional insulation is not continuous where specified in this Table.

TABLE 1312.4.4.2 ASSEMBLY U-FACTORS FOR ENGINEERED METAL BUILDING WALLS

INSULATION SYSTEM	RATED R-VALUE OF INSULATION	TOTAL RATED R-VALUE OF INSULATION	OVERALL U-FACTOR FOR ENTIRE BASE WALL ASSEMBLY	OVERALL U-FACTOR FOR ASSEMBLY OF BASE WALL PLUS CONTINUOUS INSULATION (UNINTERRUPTED BY FRAMING)					
				RATED R-VALUE OF CONTINUOUS INSULATION					
				R-5.6	R-11.2	R-16.8	R-22.4	R-28	R-33.6
Single Layer of Mineral Fiber Batt									
	None	0	U-1.180	0.161	0.086	0.059	0.045	0.036	0.030
	R-6	6	U-0.184	0.091	0.060	0.045	0.036	0.030	0.026
	R-10	10	U-0.134	0.077	0.054	0.051	0.033	0.028	0.024
	R-11	11	U-0.123	0.073	0.052	0.040	0.033	0.028	0.024
	R-13	13	U-0.113	0.069	0.050	0.039	0.032	0.027	0.024
	R-16	16	U-0.093	0.061	0.046	0.036	0.030	0.026	0.023
	R-19	19	U-0.084	0.057	0.043	0.035	0.029	0.025	0.022
Double Layer of Mineral Fiber Batt									
	R-6 + R-13	19	U-0.070	N/A	N/A	N/A	N/A	N/A	N/A
	R-10 + R-13	23	U-0.061	N/A	N/A	N/A	N/A	N/A	N/A
	R-13 + R-13	26	U-0.057	N/A	N/A	N/A	N/A	N/A	N/A
	R-19 + R-13	32	U-0.048	N/A	N/A	N/A	N/A	N/A	N/A

Comment [AS58]: From ASHRAE Standard 90.1-07, addendum g

1312.4.4.5 Below-grade wall insulation. All below-grade walls shall comply with the insulation *R*-value or equivalent *C*-factor as specified in Tables 1312.2.1-(1) or 1312.2.1 (2). That portion of below grade wall that also is exposed above-grade shall comply with this section as long as it does not exceed 15 percent of that total wall area. *C*-factor is similar to *U*-Factor but it does not include interior and exterior air films, and the effect of earth.

Comment [AS59]: OR amendment to clarify how to apply requirements when a basement wall also ends up above-grade.

1312.4.4.5.1 When the portion of wall above grade is 15 percent or greater and is insulated in a *non-continuous* insulation manner, such as with batt insulation between steel or wood framing on the interior side, insulation for the above-grade portions shall meet the above-grade *R*-value as specified requirement for those walls.

1312.4.4.5.2 When a wall consists of above-grade 15 percent and greater in area, and below-grade portions are insulated in a *continuous insulation* manner, either the above-grade portions and below-grade portions may comply with either each respective requirement, or the greater of the insulation requirements.

Comment [AS60]: This is generally stated in ASHRAE 90.1 but it does not "allow" entire wall to be insulated the same – this language is "permissive."

1312.1.2.3 1312.4.5 Batt insulation. Wall batt insulation shall be installed flush with the heated side of the cavity. Floor insulation shall be installed in a permanent manner in substantial contact with the surface being insulated. Floor batt insulation supports shall be installed so spacing is not more than 24 inches (610 mm) on center.

1312.1.3 1312.5 Windows and doors. All windows shall comply with this section. Refer to Section 1312.2 for performance requirements.

Exceptions:

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

1312.1.3.1 1312.5.1 U-factors. *U*-factors for exterior windows and doors shall include the effects of the window frame and shall be determined using the commercial size category values listed in Chapter 3031, 2004 2005 ASHRAE Handbook of Fundamentals, Table No. 4, or rated according to the National Fenestration Rating Council (NFRC) 100-2004 2004 (E1A5) Version 2 Procedure for Determining Fenestration Product Thermal Performance. *U*-factors shall be certified through the NFRC Fenestration Thermal Performance Rating Certification and Labeling Program.

1312.1.3.2 1312.5.2 Shading Solar heat gain coefficient (SHGC). For calculations, opaque portions of doors shall have a shading solar heat gain coefficient of zero. Shading Solar heat gain coefficients for glazing shall be taken from Chapter 3031, 2004 2005 ASHRAE Handbook of Fundamentals; or manufacturers test data; or certified according to NFRC 200-2004 2004 (E1A3). Edition Procedure for Determining Solar Heat Gain Coefficient (SHGC) at normal incidence. The center-of-glass overall values consider type of frame material and operator for the shading coefficient SHGC at normal incidence may be converted from the SHGC by dividing the SHGC by a factor of 0.87. SHGC shall be certified through the NFRC Certification and Labeling Program.

~~1312.1.3.3~~ **1312.5.3 Certification and labeling.** Windows shall be certified and labeled according to the procedures specified in Sections 1312.5.1 and 1312.5.2. Windows shall have a temporary label not to be removed before inspection.

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

1312.6 Concrete slab floors—above—grade. The exterior perimeter of above-grade concrete slab floors shall be insulated with either the same insulation amount that is required for the exterior wall above that floor or with R-10 continuous insulation, whichever is less.

Metal suspension, subframing systems for exterior cladding shall not exceed six percent of exterior slab floor perimeter surface area.

Example of acceptable horizontal metal standoff area for metal subframing:
 $120'' \text{ (length of slab section)} * 6'' \text{ (slab height)} = 720 \text{ in}^2 \text{ slab perimeter area}$
 $1 \text{ bracket} * 6.3'' \text{ high} * 3.15'' \text{ wide} = 20 \text{ in}^2$
 $2 \text{ brackets} * 3.15'' \text{ high} * 3.15'' \text{ wide} = 20 \text{ in}^2$
 $(20 + 20) / 720 = 6 \text{ percent of exterior wall stud}$

~~1312.1.2.4~~ **1312.7 Heated slabs—on—grade.** Insulation for heated slabs—on—grade installed inside the foundation wall, shall extend downward from the top of the slab a minimum distance of 24 inches (610 mm) or downward and under the slab for a combined minimum distance of 24 inches (610 mm). Insulation for heated slabs—on—grade installed outside the foundation shall extend downward to a minimum of 24 inches (610 mm) or to the bottom of the thickened slab edge where used as a foundation. Above grade insulation shall be protected from physical or solar damage.

~~1312.1.4~~ **1312.8 Moisture control.** A 1-perm vapor retarder shall be installed on the warm side (in winter) in all exterior floors, walls and ceilings of heated buildings.

Exceptions:

1. Masonry walls with exposed interior surfaces.
2. Slab—on—grade floors ~~need are~~ not required to have a warm—side vapor—~~barrier~~ retarder.
3. Vapor retarder may be located at a point where a minimum of 50 percent of the required R-value of insulation materials is located on the exterior-side of exterior wall systems that incorporate continuous rigid insulation on the exterior side of vapor retarder.
34. The building official may require designed moisture control systems for refrigerated buildings, buildings covering swimming pools or similar buildings with unusual potential for moisture damage.
45. The building official may accept designed moisture control systems which may include vapor barriers, ventilation, dehumidification or combinations thereof.

A ground cover shall be installed in the crawl space for both new and existing buildings when insulation is installed. Ground cover shall be 6-mil black polyethylene or other approved

Comment [AS61]: This addresses the installation of an exterior Weather-Resistant Barrier that has is also considered a vapor retarder

material of equivalent perm rating. Ground cover shall be lapped 12 inches (305 mm) at all joints and cover the entire surface area extending full width and length of the crawl space.

See Sections 1807 for dampproofing and waterproofing and 1910 for vapor barrier requirements for concrete slab-on-grade floors.

Alternative 1 for 1312.9:

~~1312.1.1~~ **1312.9 Air leakage.** ~~Penetrations or through openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, or weatherstripped, or otherwise sealed to limit infiltration and exfiltration.~~

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

Exception: ~~Openings required to be fire resistant.~~

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

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

The following areas of the building envelope shall be sealed, caulked, gasketed, or weatherstripped to minimize air leakage:

- (1) joints around fenestration and door frames
- (2) junctions between walls and foundations, between walls at building corners, between walls and structural floors or roofs, and between walls and roof or wall panels
- (3) openings at penetrations of utility services through roofs, walls, and floors
- (4) site-built fenestration and doors
- (5) building assemblies used as ducts or plenums
- (6) joints, seams and penetrations of vapor retarders and vapor barriers
- (7) all other openings in the building envelope

1312.9.1 Fenestration and doors. Air leakage for fenestration and doors shall be determined in accordance with NFRC 400. Air leakage shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council, and shall be labeled and certified by the manufacturer.

Air leakage shall not exceed 1.0 cfm/ft² for glazed swinging entrance and revolving doors and 0.4 cfm/ft² for all other products

Exceptions:

1. Site-built fenestration and doors.
2. For garage doors, air leakage determined by test at standard test conditions in accordance with ANSI/DASMA 105 shall be an acceptable alternate for compliance with air leakage requirements.

Comment [AS62]: This amended requirement is from section 5.4.3.1 of ASHRAE 90.1-07

Comment [AS63]: This from section 5.4.3.2 of ASHRAE 90.1-07

1312.9.2 Loading dock weatherseals. Cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.

Comment [AS64]: This from section 5.4.3.3 of ASHRAE 90.1-07

1312.9.3 Vestibules. Building entrances that separate conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to be open at the same time. Interior and exterior door shall have a minimum distance between them of not less than 7 feet or a distance that will comply with accessibility requirements of Chapter 11 when in the closed position. Automatic door opening devices shall be required to operate independently; one control shall not operate both the interior and exterior doors simultaneously. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space.

Comment [AS65]: Source is section 5.4.3.4 of ASHRAE 90.1-07

Exceptions:

1. Doors not intended to be used as a building entrance.
2. Doors opening directly from a dwelling unit or guest room.
3. Building entrances in buildings located in Climate Zone 1 that are less than four stories above grade and less than 10,000 square feet in area.
4. Building entrances located in Climate Zone 2 that are less than 1,000 square feet in area.
5. Doors that open directly from a space that is less than 3,000 square feet in area and is separate from the building entrance.
6. Revolving doors are exempt. The hinged entrance doors adjacent to a revolving door are not exempt.

~~1312.1.2.2~~ **1312.9.4 Recessed lighting fixtures.** ~~Recessed light fixtures shall not be installed in ceilings separating conditioned from unconditioned spaces. Recessed lighting fixtures installed within an insulated component of the building envelope shall meet one of the following requirements:~~

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

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

Alternative 2 for 1312.9:

~~1312.1.1~~ **1312.9 Air Leakage Building envelope sealing:** The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, or out of the conditioned space. All air barrier components of each envelope assembly shall be clearly

identified on construction documents, and the joints, interconnections, and penetrations of the air barrier components shall be detailed. Penetrations or through openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, or weather stripped, or otherwise sealed to limit infiltration and exfiltration.

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

Exception: Openings required to be fire resistant. Building envelopes of buildings more than seven stories above grade or semi-conditioned spaces, provided the following areas of those building envelope are sealed, caulked gasketed or weather-stripped to minimize air leakage:

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

1312.9.1 Characteristics. The continuous air barrier shall have the following characteristics and shall also comply with Section 1312.9.2:

- (1) The continuous air barrier shall be continuous throughout the envelope (at the lowest floor, exterior walls, and ceiling or roof), with all joints and seams sealed and with sealed connections between all transitions in planes and changes in materials and at all penetrations.
- (2) The air barrier component of each assembly shall be joined and sealed in a flexible manner to the air barrier component of adjacent assemblies, allowing for the relative movement of these assemblies and components.
- (3) The continuous air barrier shall be capable of withstanding positive and negative combined design wind, fan, and stack pressures without damage or displacement and shall transfer the load to the structure. It shall not displace adjacent materials under full load.
- (4) The continuous air barrier shall be installed in accordance with manufacturer's instructions and in such a manner as to achieve the performance requirements.
- (5) Where lighting fixtures with ventilation or other similar objects are to be installed in such a way as to penetrate the continuous air barrier, provisions shall be made to maintain the integrity of the continuous air barrier.

Exception: Buildings that comply with Section 1312.9.2 (3) are not required to comply with either Sections 1312.9.1 (1) or 1312.9.1 (5).

1312.9.2 Compliance options. Compliance of the continuous air barrier for the opaque building envelope shall comply with Section 1312.9.1 and shall be demonstrated by one of the following:

- (1.)using individual materials that have an air permeance not exceeding 0.004 cfm/ft² under a pressure differential of 0.3 in. w.g. (1.57 psf) (0.02 L/s.m² at 75 Pa) when tested in accordance with ASTM E 2178; or

- (2.) using assemblies of materials and components that have an average air leakage rate not to exceed 0.4 cfm/ft² under a pressure differential of 0.3 in. w.g. (1.57 psf) (0.02 L/s.m² at 75 Pa) when tested in accordance with ASTM E 1677; or
- (3.) testing the completed building and demonstrating that the air leakage rate of the building envelope does not exceed 0.4 cfm/ft² at a pressure differential of 0.3 in. w.g. (1.57 psf) (0.02 L/s.m² at 75 Pa) in accordance with ASTM E 779 or an equivalent approved method.

The following Sections address generic building materials and assemblies that comply with the air barrier requirements of Sections 1312.9.2 (1) and 1312.9.2 (2) and discusses in detail the three compliance methods in Section 1312.9.2 by providing guidance to those performing compliance testing.

1312.9.2.1 Building materials and assemblies. The following materials shall comply with Section 1312.9.2 (1):

- (1) plywood – minimum 3/8 in. (10 mm)
- (2) oriented strand board – minimum 3/8 in. (10 mm)
- (3) extruded polystyrene insulation board – minimum 3/4 in. (19 mm)
- (4) foil-back urethane insulation board – minimum 3/4 in. (19 mm)
- (5) exterior or interior gypsum board – minimum 1/2 in. (12 mm)
- (6) cement board – minimum 1/2 in. (12 mm)
- (7) built up roofing membrane
- (8) modified bituminous roof membrane
- (9) fully adhered single-ply roof membrane
- (10) a Portland cement/sand parge or gypsum plaster – minimum 5/8 in. (16 mm)
- (11) cast-in-place or precast concrete
- (12) fully grouted concrete block masonry
- (13) sheet steel

The following materials shall comply with Section 1312.9s.2 (2):

- (1) assemblies that include a continuous air barrier material and comply with either ASTM E 2357 or ASTM E 1677 and 1312.9.2 (2).
- (2) concrete masonry walls with:
 - a. one application of block filler and two applications of a paint or sealer coating, or
 - b. a Portland cement/sand parge stucco or plaster minimum 1/2 in. (12 mm) thick.

All joints shall be sealed and the other requirements of Sections 1312.9.1 shall be complied with for the material or assembly to comply as part of a continuous air barrier.

1312.9.2.2 Air barrier compliance testing.

1312.9.2.2.1 Material air permeance testing to comply with Section 1312.9.2(1). Individual materials proposed as part of the continuous air barrier shall be tested by the manufacturer in accordance with ASTM E 2178. Following are comments referring to ASTM E 2178.

The effectiveness of fluid-applied materials in sealing a rough surface is dependent on application thickness. Fluid-applied materials shall be tested as a 1 x 1 M film applied to a concrete block substrate with cells open at the top, using ASTM E 2178. This will

verify the dry film thickness of material needed for an effective application and shall be reported by the manufacturer.

1312.9.2.2.2 Assembly air permeance testing to comply with Section 1312.9.2(2). Assemblies of materials proposed as part of the continuous air barrier shall be tested by the manufacturer in accordance with ASTM E 2357 or ASTM E 1677. Metal building assemblies are allowed to be tested in accordance with ASTM E 1680. Following are comments referring to ASTM E 1677:

- (1) **Paragraph 1.1:** Although the original intent of this test was to test frame walls for low-rise residential buildings, this test specification is allowed to be used to verify the air permeance of opaque wall assemblies of materials and to report permeance of an opaque wall system design for any building type and height. (See also ASTM E 1677, Annex Paragraph A.1.2.1) Any combination of materials is allowed to be tested so long as the specimen is representative of the complete opaque building wall proposed for a building and primary air barrier material is sealed to the perimeter test chamber.
- (2) **Paragraph 5.1.1:** Maximum acceptable air permeance of an assembly shall be in accordance with ASHRAE Standard 90.1, Section 5.4.3.1.2 (b).
- (3) **Paragraph 5.1.2:** Test pressure selected for the test shall comply with the design wind and gust requirements for the intended application. Test pressures shall be recorded and reported by the manufacturer.
- (4) **Paragraph 5.1.3 and 5.1.4:** The water resistance and water vapor permeance testing and reporting requirements in ASTM E 1677 are not mandatory to comply with requirements of ASHRAE Standard 90.1.

1312.9.2.2.3 Whole-building air leakage rate testing to comply with Section 1312.9.2-3. Whole-building testing as the compliance method shall be accomplished in accordance with ASTM E 779 or an approved similar test. Tests shall be accomplished using either pressurization or depressurization or both. The building shall not be tested unless it is verified that the continuous air barrier is in place and installed without failures in accordance with the installation instructions so that repairs to the continuous air barrier, if needed to comply with the required air leakage rate, can be completed in a timely manner. Following are comments referring to ASTM E 779:

- (1) **Under ASTM E 779 it is permissible to test using the building's HVAC system.** In buildings with multistory HVAC systems and shafts, it is permissible to test using the building's mechanical system using CAN/CGSB-149.15-96, *Determination of the Overall Envelope Airtightness of Buildings by the Fan Pressurization Method Using the Building's Air Handling Systems* (Canadian General Standards Board, Ottawa).
- (2) **In lieu of the fan pressurization method described in ASTM E 779, a tracer gas test of the building air change rate in accordance with ASTM E 741 is also allowed. The tracer gas test shall be run with building HVAC fans turned off.**
- (3) **Section 8.1:** For purposes of this test, a multi-zone building shall be configured as a single zone by opening all interior doors and otherwise connecting the interior spaces as much as possible. It is also allowed to test a smaller section of the building, provided the test area can be isolated from neighboring conditioned

zones by balancing the pressure in adjacent conditioned zones to that in the zone being tested. This can be very difficult to do in buildings with multistory shafts and HVAC systems. If a smaller section of the building is tested, provide a drawing showing the zone(s) tested, the pressure boundaries, and a diagram of the testing equipment configuration.

- (4) Section 8.2: Seal all intentional functional openings that are not used in the test to introduce air, such as exhaust and relief louvers, grilles, and dryer vents, using plastic sheeting and duct tape or similar materials. All plumbing traps shall be filled with water.
- (5) Section 8.10: The test pressure range shall be from 10 to 80 Pa. If approved by the Building Official, lower test pressures are acceptable, but the upper limit shall not be less than 50 Pa.
- (6) Section 9.4: If both pressurization and depressurization are not tested, plot the air leakage against the corrected DP for either pressurization or depressurization.
- (7) Section 9.6.41: If the pressure exponent n is less than 0.5 or greater than 1, corrective work shall be performed to the continuous air barrier and the test shall be re-run.
- (8) Section 10.4: Report the air leakage rate normalized over the area of enclosure (see Section 3.2 definition of *air leakage rate of the building enclosure*) in cfm/ft^2 at 0.3 in. w.g. (1.57 psf) ($\text{L}/\text{s}\cdot\text{m}^2$ at 50 Pa).

1312.9.3 Fenestration and Doors: Air leakage for fenestration and doors shall be determined in accordance with NFRC 400. Air leakage shall be determined by an independent laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council and shall be labeled and certified by the manufacturer.

Air leakage shall not exceed 1.0 cfm/ft^2 for glazed swinging entrance doors and for revolving doors, and 0.4 cfm/ft^2 for all other products.

Exceptions:

1. Field fabricated fenestration and doors that are weather-stripped.
2. For garage doors, air leakage determined by test at standard test conditions in accordance with ANSI/DASMA 105 shall be an acceptable alternate for compliance with air leakage requirements.

1312.9.4 Loading dock weatherseals. Cargo doors and loading dock doors shall be equipped with weatherseals to restrict infiltration when vehicles are parked in the doorway.

1312.9.5 Vestibules. Building entrances that separate conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to be open at the same time. Interior and exterior door shall have a minimum distance between them of not less than 7 feet or a distance that will comply with accessibility requirements of Chapter 11 when in the closed position. Automatic door opening devices shall be required to operate independently; one control shall not operate both the interior and exterior doors simultaneously. The exterior envelope of conditioned vestibules shall comply with the requirements for a conditioned space.

Exceptions:

Comment [AS66]: This from section 5.4.3.3 of ASHRAE 90.1-07

Comment [AS67]: Source is section 5.4.3.4 of ASHRAE 90.1-07

1. Doors not intended to be used as a building entrance.
2. Doors opening directly from a dwelling unit or guest room.
3. Building entrances in buildings located in Climate Zone 1 that are less than four stories above grade and less than 10,000 square feet in area.
4. Building entrances located in Climate Zone 2 that are less than 1,000 square feet in area.
5. Doors that open directly from a space that is less than 3,000 square feet in area and is separate from the building entrance.
5. Revolving doors are exempt. The hinged entrance doors adjacent to a revolving door are not exempt.

~~1312.1.2.2~~ **1312.9.6 Recessed lighting fixtures.** ~~Recessed light fixtures shall not be installed in ceilings separating conditioned from unconditioned spaces.~~ Recessed lighting fixtures installed within an insulated component of the building envelope shall meet one of the following requirements:

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

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