

2021 Virginia Construction Code

CHAPTER 13 ENERGY EFFICIENCY

SECTION 1301 GENERAL

[E] 1301.1 Scope.

This chapter governs the design and construction of buildings for energy efficiency.

[E] 1301.1.1 Criteria.

Buildings shall be designed and constructed in accordance with the [International Energy Conservation Code](#).

1301.1.1.1 Changes to the [International Energy Conservation Code](#) (IECC).

The following changes shall be made to the IECC:

1. Add [Section C402.1.6](#) to the IECC to read:
C402.1.6 Groups F, S, and U. Appendix CD may be used as an alternative to the *building thermal envelope* provisions of this code for Groups F, S, and U.
2. Add an exception to the first paragraph of [Section C403.7.7](#) of the IECC to read:
Exception: Where a grease duct serving a Type I hood is installed in accordance with [Section 506.3](#) of the *International Mechanical Code*, motorized or gravity dampers shall not be installed.
3. Add [Section C403.2.2.1](#) to the IECC to read:
C403.2.2.1 Dwelling unit mechanical ventilation. Mechanical ventilation shall be provided for dwelling units in accordance with the [International Mechanical Code](#).
4. Delete [Section C403.7.5](#) and [Table C403.7.5](#) of the IECC.
5. Delete [Sections C404.5](#) through [C404.5.2.1](#) of the IECC, including Tables.
6. Change [Section C405.4](#) of the IECC to read:
C405.4 Exterior lighting. All exterior lighting, other than low-voltage landscape lighting, shall comply with [Section C405.4.1](#).
Exception: Where approved because of historical, safety, signage, or emergency considerations.
7. Change [Section C502.1](#) of the IECC to read:
C502.1 General. Additions to an existing building, building system or portion thereof shall conform to the provisions of [Section 805](#) of the *Virginia Existing Building Code*.
8. Delete [Sections C502.2](#) through [C502.3.6.2](#) of the IECC.
9. Change [Section C503.1](#) of the IECC to read:
C503.1 General. Alterations to any *building* or structure shall comply with the requirements of [Chapter 6](#) of the *Virginia Existing Building Code*.
10. Delete [Sections C503.2](#) through [C503.5](#) of the IECC.
11. Change [Section C504.1](#) of the IECC to read:
C504.1 General. Buildings and structures, and parts thereof, shall be repaired in compliance with [Section 510](#) of the *Virginia Existing Building Code*.
12. Delete [Section C504.2](#) from the IECC.
13. Add Appendix CD to the IECC to read:

APPENDIX CD

BUILDING ENVELOPE

REQUIREMENTS

CD101 Scope

CD101.1 General. These provisions shall be permitted as an alternative to building thermal envelope requirements for *building* areas containing uses that are classified as Group F, S or U.

CD102 Building Envelope Requirements

CD102.1 Insulation and fenestration criteria. The building thermal envelope shall meet the requirements of Tables CD102.2(1) and CD102.3 based on the climate zone specified in Chapter 3CE. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CD102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.

CD102.2 Specific insulation requirements. Opaque assemblies shall comply with [Table CD102.2\(1\)](#).

CD102.2.1 Roof assembly. The minimum thermal resistance (*R*-value) of the insulating material

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installed either between the roof framing or continuously on the roof assembly shall be as specified in [Table CD102.2\(1\)](#), based on *construction* materials used in the roof assembly.

Exception: Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25.4 mm) or less and where the area weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in [Table CD102.2\(1\)](#).

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation.

CD102.2.2 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section CD102.2.2.1 or CD102.2.2.2.

TABLE CD102.2(1)
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE^a METHOD

CLIMATE ZONE	3	4 EXCEPT MARINE	5 AND MARINE 4
Roofs			
Insulation entirely above roof deck	R-15ci	R-15ci	R-15ci
Metal buildings (with R-5 thermal blocks ^a) ^b	R-19	R-19	R-19
Attic and other	R-30	R-30	R-30
Walls, above grade			
Mass	R-5.7ci ^{c,e}	R-5.7ci ^c	R-7.6ci
Metal building ^b	R-13	R-13	R-13 + R-13ci
Metal framed	R-13	R-13	R-13 + R-3.8ci
Wood Framed and other	R-13	R-13	R-13
Walls, below grade			
Below-grade wall ^d	NR	NR	NR
Floors			
Mass	R-5ci	R-10ci	R-10ci
Joists/framing	R-19	R-19	R-19
Slab-on-grade floors			
Unheated slabs	NR	NR	NR
Heated slabs	R-7.5 for 12" below	R-7.5 for 12" below	R-7.5 for 24" below
Opaque Doors			
Swinging	U-0.70	U-0.70	U-0.70
Roll-up or sliding	U-1.45	U-1.45	U-1.45

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m², 1 pound per cubic foot = 16 kg/m³.

ci = Continuous Insulation, NR = No Requirement

- a. Thermal blocks are a minimum R-5 of rigid insulation which extends 1-inch beyond the width of the purlin on each side, perpendicular to the purlin.
- b. Assembly description can be found in [Table CD102.2\(2\)](#).
- c. R-5.7ci is allowed to be substituted with concrete block walls complying with [ASTM C90](#), ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h·ft² °F.
- d. Where heated slabs are below grade, below-grade walls shall

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comply with the exterior insulation requirements for perimeter insulation according to the heated slab-on-grade construction.

e. Insulation is not required for mass walls in Climate Zone 3A located below the “Warm-Humid” line, and in Zone 3B.

TABLE CD102.2(2)
METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTIONS	REFERENCE
R-19 + R-10	Filled Cavity Roof Thermal blocks are a minimum, R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin.	ASHRAE/IESNA 90.1-2004 Table A2.3
R-19	Standing seam with single insulation layer. Thermal blocks are a minimum R-5 of rigid insulation, which extends 1 in. beyond the width of the purlin on each side, perpendicular to the purlin. This construction R-19 insulation batts draped perpendicularly over the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins.	ASHRAE/IESNA 90.1-2004 Table A2.3
Walls		
R-13	Single insulation layer The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.	ASHRAE/IESNA 90.1-2004 Table A2.3
R-13 + R-13ci	Double insulation layer The first layer of R-13 insulation batts is installed continuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.	ASHRAE/IESNA 90.1-2004 Table A2.3

For SI: 1inch = 25.4 mm.

CD102.2.2.1 Above-grade walls. Above-grade walls are those walls covered by Section CD102.2.3 on the exterior of the *building* and completely above grade or walls that are more than 15 percent above grade.

CD102.2.2.2 Below-grade walls. Below-grade walls covered by Section CD102.2.4 are basement or first-story walls associated with the exterior of the *building* that are at least 85 percent below grade.

CD102.2.2.3 Above-grade walls. The minimum thermal resistance (*R*-value) of the insulating material(s) installed in the wall cavity between the framing members and continuously on the walls shall be as specified in [Table CD102.2\(1\)](#), based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units (CMU) shall not be used in determining compliance with [Table CD102.2\(1\)](#). “Mass walls” shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m²) of wall surface area or (2) 25 pounds per square foot (120 kg/m²) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg/m³).

CD102.2.4 Below-grade walls. The minimum thermal resistance (*R*-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in [Table CD102.2\(1\)](#) and shall extend to a depth of 10 feet (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CD102.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (*R*-

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value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in [Table CD102.2\(1\)](#), based on construction materials used in the floor assembly. "Mass floors" shall include floors weighing at least (1) 35 pounds per square foot (170 kg/m²) of floor surface area or (2) 25 pounds per square foot (120 kg/m²) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1900 kg/m³).

CD102.2.6 Slabs on grade. The minimum thermal resistance (*R*-value) of the insulation around the perimeter of unheated or heated slab-on-grade floors shall be as specified in [Table CD102.2\(1\)](#). The insulation shall be placed on the outside of the foundation or on the inside of a foundation wall. The insulation shall extend downward from the top of the slab for a minimum distance as shown in the table or to the top of the footing, whichever is less, or downward to at least the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table.

CD102.2.7 Opaque doors. Opaque doors (doors having less than 50-percent glass area) shall meet the applicable requirements for doors as specified in [Table CD102.2\(1\)](#) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

CD102.3 Fenestration. Fenestration shall comply with [Table CD102.3](#).

**TABLE CD102.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION**

CLIMATE ZONE	3	4 EXCEPT MARINE	5 AND MARINE 4
Vertical fenestration (40% maximum of above-grade wall)			
<i>U</i> -factor			
Framing materials other than metal or without metal reinforcement or cladding			
<i>U</i> -Factor	0.65	0.40	0.35
Metal framing with or without thermal break			
Curtain Wall/Storefront <i>U</i> -factor	0.60	0.50	0.45
Entrance Door <i>U</i> -factor	.90	.85	.80
All Other <i>U</i> -factor ^a	.65	.55	.55
SHGC-All Frame Types			
SHGC: $PF < 0.25$.25	.40	.40
SHGC: $0.25 < PF < 0.5$.33	NR	NR
SHGC: ≥ 0.5	0.40	NR	NR
Skylights (3% maximum)			
Glass			
<i>U</i> -Factor	0.90	0.60	0.60
SHGC	0.40	0.40	0.40
Plastic			
<i>U</i> -Factor	1.30	1.30	1.30
SHGC	0.35	0.62	0.62

NR = No Requirement, PF = Projection Factor (See Section CD102.3.2)

- a. All others includes operable windows, fixed windows and non-entrance doors.

CD102.3.1 Maximum area. The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in [Table CD102.3](#). The skylight area shall not exceed the percentage of the gross roof area specified in [Table CD102.3](#).

CD102.3.2 Maximum *U*-factor and SHGC. For vertical fenestration, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in [Table CD102.3](#), based on the window projection factor. For skylights, the maximum *U*-factor and solar heat gain coefficient (SHGC) shall be as specified in [Table CD102.3](#). The window projection factor shall be determined in accordance with [Equation CD-1](#).

$$PF = A/B$$

where:

(Equation CD-1)

PF = Projection factor (decimal).

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A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately, or an area-weighted PF value shall be calculated and used for all windows and glass doors.

CD102.4 Air leakage.

CD102.4.1 Window and door assemblies. The air leakage of window and sliding or swinging door assemblies that are part of the building envelope shall be determined in accordance with [AAMA/WDMA/CSA 101/I.S.2/A440](#), or NFRC 400 by an accredited, independent laboratory, and labeled and certified by the manufacturer and shall not exceed the values in [Section 402.4.2](#) of the 2006 IECC.

Exception: Site-constructed windows and doors that are weatherstripped or sealed in accordance with Section CD102.4.3.

CD102.4.2 Curtain wall, storefront glazing and commercial entrance doors. Curtain wall, storefront glazing and commercial glazed swinging entrance doors and revolving doors shall be tested for air leakage at 1.57 pounds per square foot (psf) (75 Pa) in accordance with [ASTM E283](#). For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft²) (5.5 m³/h × m²) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft² (18.3 m³/h × m²) of door area when tested in accordance with [ASTM E283](#).

CD102.4.3 Sealing of the building envelope. Openings and penetrations in the building envelope shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and location. Joints and seams shall be sealed in the same manner or taped or covered with a moisture vapor-permeable wrapping material. Sealing materials spanning joints between construction materials shall allow for expansion and contraction of the construction materials.

CD102.4.4 Outdoor air intakes and exhaust openings. Stair and elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be equipped with not less than a Class I motorized, leakage-rated damper with a maximum leakage rate of 4 cfm per square foot (6.8 L/s – C m²) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance with AMCA 500D.

Exception: Gravity (nonmotorized) dampers are permitted to be used in buildings less than three stories in height above grade.

CD102.4.5 Loading dock weather seals. Cargo doors and loading dock doors shall be equipped with weather seals to restrict infiltration when vehicles are parked in the doorway.

CD102.4.6 Vestibules. A door that separates conditioned space from the exterior shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped 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 open at the same time.

Exceptions:

1. Buildings in Climate Zones I and 2 as indicated in [Figure C301.1](#) and [Table C301.1](#).
2. Doors not intended to be used as a building entrance door, such as doors to mechanical or electrical equipment rooms.
3. Doors opening directly from a sleeping unit or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m²) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CD102.4.7 Recessed luminaires. When installed in the building envelope, recessed luminaires 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 sealed or gasketed to prevent air leakage into the unconditioned space.
2. Type IC or non-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 airtight assembly manufactured for this purpose, while maintaining required

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clearances of not less than 0.5 inch (12.7 mm) from combustible material and not less than 3 inches (76 mm) from insulation material.

3. Type IC rated, in accordance with [ASTM E283](#) admitting no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) of air movement from the conditioned space to the ceiling cavity. The luminaire shall be tested at 1.57 psf (75 Pa) pressure difference and shall be labeled.

CD102.5 Moisture control. All framed walls, floors and ceilings not ventilated to allow moisture to escape shall be provided with an approved vapor retarder having a permeance rating of 1 perm (5.7×10^{-11} kg/Pa · s · m²) or less, when tested in accordance with the dessicant method using Procedure A of [ASTM E96](#). The vapor retarder shall be installed on the warm-in-winter side of the insulation.

Exceptions:

1. *Buildings* located in Climate Zones 1 through 3 as indicated in [Figure C301.1](#) and [Table C301.1](#).
2. In *construction* where moisture or its freezing will not damage the materials.
3. Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided.

14. Change the wood frame wall *R*-value categories for Climate Zones 3A, 4A and 5A in [Table R402.1.3](#) to read:

	Wood Frame Wall <i>R</i> -Value
	15 or 13+1 ^h

15. Change the frame wall *U*-factor categories for Climate Zones 3A, 4A and 5A in [Table R402.1.2](#) to read:

	Frame Wall <i>U</i> -Factor
	0.079

16. Add an exception to [Section R401.3](#) of the IECC to read:

Exception: Where approved, certificates for multifamily dwelling units shall be permitted to be located off-site at an identified location.

17. Change [Section R402.2.4](#) of the IECC to read:

R402.2.4 Access hatches and doors. Access doors from conditioned spaces to unconditioned spaces (e.g., attics and crawl spaces) shall be weatherstripped and insulated in accordance with the following values:

1. Hinged vertical doors shall have a minimum overall R-5 insulation value.
2. Hatches and scuttle hole covers shall be insulated to a level equivalent to the insulation on the surrounding surfaces.
3. Pull down stairs shall have a minimum of 75 percent of the panel area having R-5 rigid insulation.

Access shall be provided to all equipment that prevents damaging or compressing the insulation. A wood-framed or equivalent baffle or retainer is required to be provided when loose fill insulation is installed, the purpose of which is to prevent the loose-fill insulation from spilling into the living space when the attic access is opened and to provide a permanent means of maintaining the installed R-value of the loose-fill insulation.

18. Change the title of the “Insulation Installation Criteria” category of [Table R402.4.1.1](#); change the “Shower/tub on exterior wall” category of [Table R402.4.1.1](#), and add footnotes “c” and “d” to [Table R402.4.1.1](#) to read:

Component	Air Barrier Criteria	Insulation Installation Criteria
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall be installed on the interior side and separate the exterior walls from the showers and tubs	Exterior walls adjacent to showers and tubs shall be insulated.

- c. Air barriers used behind showers and tubs on exterior walls shall be of a permeable material that does not cause the entrapment of moisture in the stud cavity.
- d. Structural integrity of headers shall be in accordance with the applicable building code

19. Change [Section R402.4.1.2](#) of the IECC to read:

R402.4.1.2 Testing. The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). A written report of the results of the test shall be signed by the party conducting the test and provided to the building official. Testing shall be conducted by a Virginia licensed general contractor, a Virginia licensed HVAC contractor, a Virginia licensed home inspector, a Virginia *registered design professional*, a certified BPI Envelope Professional, a certified HERS rater, or a certified duct and envelope tightness rater. The party conducting the test shall have been trained on the equipment used to perform the test. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

Note: Should additional sealing be required as a result of the test, consideration may be given to the issuance of a temporary certificate of occupancy in accordance with [Section 116.1.1](#).

During testing:

1. Exterior windows and doors and fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.
 2. Dampers, including exhaust, intake, makeup air, backdraft and flue dampers, shall be closed, but not sealed beyond intended infiltration control measures.
 3. Interior doors, if installed at the time of the test, shall be open.
 4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.
 5. Heating and cooling systems, if installed at the time of the test, shall be turned off.
 6. Supply and return registers, if installed at the time of the test, shall be fully open.
20. Change [Section R402.4.1.3](#) of the IECC to read:
- R402.4.1.3 Leakage rate.** When complying with [Section R401.2.1](#), the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 3 through 5, when tested in accordance with [Section R402.4.1.2](#).
21. Add Section R403.1.3 to the IECC to read:
- R403.1.3 Heat pump as primary space heat source.** Electric resistance heat shall not be used as the primary heat source for electric space heating if a ducted or ductless heat pump can be installed. Electric resistance space heating may be used for defrost, supplemental or emergency heat. A heat pump shall be designed so that, except during defrost or emergency heating modes, supplemental heating does not energize unless the outdoor temperature is below 40°F (4°C).
22. Change the last paragraph of [Section R403.3.5](#) of the IECC to read:
- A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. The licensed mechanical contractor installing the mechanical system shall be permitted to perform the duct testing. The contractor shall have been trained on the equipment used to perform the test.
23. Change [Section R403.3.7](#) of the IECC to read:
- R403.3.7 Building cavities.** Building framing cavities used as ducts or plenums shall comply with VRC [Section M1601.1.1](#).
24. Change [Section R403.7](#) of the IECC to read:
- R403.7 Equipment and appliance sizing.** Heating and cooling equipment and appliances shall be sized in accordance with ACCA Manual S or other approved sizing methodologies based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.

Exception: Heating and cooling equipment and appliance sizing shall not be limited to the capacities determined in accordance with Manual S or other approved sizing methodologies where any of the following conditions apply:

1. The specified equipment or appliance utilizes multi-stage technology or variable refrigerant flow technology and the loads calculated in accordance with the approved heating and cooling methodology fall within the range of the manufacturer's published capacities for that equipment or appliance.

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2. The specified equipment or appliance manufacturer's published capacities cannot satisfy both the total and sensible heat gains calculated in accordance with the approved heating and cooling methodology and the next larger standard size unit is specified.
 3. The specified equipment or appliance is the lowest capacity unit available from the specified manufacturer.
25. Change [Section R406.3.2](#) of the IECC to read:
R406.3.2 On-site renewables are included. When onsite renewable energy is included for compliance using the ERI analysis per [Section R406.4](#), the building thermal envelope shall be greater than or equal to levels of energy efficiency and solar heat gain coefficient in [Table R402.1.2](#), with a ceiling *U*-factor of 0.026 and a frame wall *U*-factor of 0.060, or [Table R402.1.3](#), with a ceiling *R*-value of 49 and a wood frame wall *R*-value of 20 or 13+5.
 26. Change [Section R501.1](#) of the IECC to read:
R501.1 Scope. The provisions of the *Virginia Existing Building Code* shall control the alteration, repair, addition and *change of occupancy* of existing buildings and structures.
 27. Delete [Sections R501.1.1](#) through [R501.6](#) of the IECC.
 28. Change [Section R502.1](#) of the IECC to read:
R502.1 General. Additions to an existing building, building system or portion thereof shall conform to the provisions of [Section 805](#) of the VEBC.
 29. Delete [Sections R502.2](#) through [R502.3.4](#) of the IECC.
 30. Change [Section R503.1](#) of the IECC to read:
R503.1 General. Alterations to any *building* or structure shall comply with the requirements of [Chapter 6](#) of the VEBC.
 31. Delete [Sections R503.1.1](#) through [R503.1.4](#) of the IECC.
 32. Change [Section R504.1](#) of the IECC to read:
R504.1 General. Buildings, structures and parts thereof shall be repaired in compliance with [Section 507](#) of the VEBC.
 33. Delete [Section R504.2](#) of the IECC.