REC-R402.4-21

VCC: 1301.1.1.1

Proponents: William Penniman (wpenniman@aol.com)

2018 Virginia Construction Code

Revise as follows:

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

21. ~~Change Sections R402.4 and R402.4.1.1 to read:~~

> ~~**R402.4 Air leakage.** The *building* thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.5.~~
>
> > ~~**R402.4.1.1 Installation (Mandatory).** The components of the *building* thermal envelope as listed in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria listed in Table R402.4.1.1, as applicable to the method of *construction.* Where required by the code official, an *approved* third party shall inspect all components and verify compliance.~~

22. ~~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 "b" and "c" to Table R402.4.1.1 to read:~~

23. ~~Change Section R402.4.1.2 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 in Climate Zone 4. 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; and~~
> 6. ~~Supply and return registers, if installed at the time of the test, shall be fully open.~~

24. ~~Change Section R403.3.3 to read:~~

> ~~**R403.3.3 Duct testing (Mandatory).** Ducts shall be pressure tested to determine air leakage by one of the following methods:~~
>
> 1. ~~Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped or otherwise sealed during the test.~~
> 2. ~~Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.~~
>
> ~~**Exception:** A duct air leakage test shall not be required where the ducts and air handlers are located entirely within the building thermal envelope.~~

~~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.~~

Reason Statement: The purpose of this proposal is to bring Virginia's standards for air leakage testing and air leakage rates into full compliance with the 2021 IECC from which the new language is drawn.

The air leakage level permitted by Virginia's 2018 Energy Conservation Code predates the 2012 IECC, which required air leakage to not exceed 3.0 air changes per hour in Virginia's climate zones. Retaining the 5.0 ACH level would make Virginia's USBC more than a decade behind the IECC, and plainly out of compliance with statutory standards. Sections 36-99A and 36-99B of the Virginia Code make clear that building codes are required to "protect the health, safety and welfare of the residents of the Commonwealth" and that deviations to reduce construction costs must nevertheless be "consistent with recognized standards of health, safety, energy efficiency and water efficiency." H2227, which was enacted in 2021, calls for adoption of energy efficiency standards that are "at least as stringent" as the latest IECC.

Reducing the maximum air infiltration to 3 air changes per hour was established as technically and economically viable when the 2012 IECC was promulgated. Following promulgation of the 2012 IECC, DOE found that the changes from 2009 improved efficiency and was cost effective for occupants in that they saved money every year and quickly recouped the cost of construction. DOE/PNNL, *National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf

The IECC requirement has remained at 3 air changes per hour in the 2015, 2018 and 2021 IECCs. If there were any technical or economic reason to adopt 5 ACH in Virginia's climate zones, the ICC has had three cycles to make the adjustments, but it has not done so. There is no valid reason for Virginia to continue to permit leaky houses that require additional heating and cooling in order to offset the infiltration of outside air.

Tightening building air sealing to test at 3 (versus 5) air changes per hour (a.k.a. "3 ACH" or "3 ACH50") is important to residents who will save money, experience greater comfort and a healthier home. Every additional air change requires additional heating and conditioning of air in the dwelling, and reflects poor sealing which leaves gaps for pests to enter the dwelling. While indoor humidity can be an issue in buildings (regardless of the tightness of construction) during periods in which spaces are not being heated or cooled, it is not a valid reason for refusing to implement the IECC's long-established standards for 3 ACH since greater air to flow through walls and ceilings increases the risks that moisture will be captured inside walls and insulation increasing the risks of mold and deterioration.

There is a broad consensus among recognized standards that tighter sealing of walls protects the health, safety and welfare of residents. To address indoor air issues, the IECC has long required whole-house mechanical ventilation for buildings that test at less than 5 ACH and has modified the envelope barrier standards. DOE has even tighter standards (2.5 ACH50 for Climate Zone 4) for its Zero-Energy program, and Passive House standards call for 0.6 ACH50. https://basc.pnnl.gov/information/infiltration-meets-ach50-requirements ; http://passivehousebuildings.com/books/phc-2019/five-principles-of-passive-house-design-and-construction/ The National Association of Home Builders has also recognized many benefits from minimizing air leakage.[1] And, EPA encourages tighter sealing of walls to reduce air infiltration (including infiltration of humid air), reduce energy waste, reduce the risks of indoor air pollution, reduce humidity and mold in walls, and reduce risks of infiltration by insects and rodents—another specific concern in Virginia's building code, which we cited. As EPA has stated, in *EnergyStar: A complete Thermal Enclosure System* (2017):

> The energy savings from comprehensive air sealing can quickly add up when you consider all the places hot or cool air can enter or escape from your home. Having a well-sealed home also means better air quality because dirt, pollen, pests, and moisture can't get in as easily. In addition, good sealing practices help protect your home against mold and moisture damage that can be caused by condensation.

[1] See NAHB, et al., "TechNote – Building Tightness Code Compliance & Air Sealing Overview", which (a) states "Air leakage in a building should be minimized;" (b) identifies benefits to residents including ""Heating & cooling energy savings; Reduced potential for moisture movement through the building thermal enclosure; Improved insulation effectiveness and reduced risk of ice dams; Reduced peak heating and cooling loads resulting in smaller HVAC equipment; Improved comfort (reduces drafts and noise); Improved indoor air quality (limits contaminants from garages, crawl spaces, attics, and adjacent units)" and (c) suggests a possible construction strategy with a goal of 2.5 ACH – stricter than the IECC.

Resiliency Impact Statement: This proposal will increase Resiliency

Improving building energy efficiency with the 3 ACH standard will increase resiliency compared to Virginia's outdated 5 ACH standard. By reducing the volume of air that needs to be reheated or cooled every day, the proposal will reduce energy usage and cost burdens. By better preserving indoor conditioned temperatures, it will help residents and communities withstand periods of power outages from storms or other causes. Improving envelope efficiency will also reduce burdens on utilities which will help them better cope with storms and other difficulties.

By reducing demands for energy generation, tightening construction will also help mitigate climate impacts and prepare Virginia's buildings and economy for a future that requires the least energy usage and related pollution possible. Climate change is already harming Virginia and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane). Growing climate dangers include harms to communities, infrastructure, people, property and the economy from rising seas, worsening storms and more severe rainfall events. Growing dangers also include rising atmospheric and water temperatures that threaten worsening heat-related illnesses, limits on economic activity, agriculture, fisheries, and our natural heritage. The likelihood of mitigating and recovering from those harms declines the longer we delay maximizing energy savings and minimizing GHG pollution.

Furthermore, saving energy will reduce occupants' utility bills while increasing their comfort. Reducing energy cost burdens will improve the *economic resiliency* of all residents, but particularly low and moderate income customers most harmed by high bills. It will also the *economic resiliency* of lenders, landlords and communities by reducing loan defaults and residents' choices between paying energy bills and rent, mortgages and other basic family needs. With buildings lasting 70 or more years, there is no excuse for not meeting standards established 10 years ago.

Cost Impact: The code change proposal will increase the cost of construction

The code change proposal will increase the cost of construction in some, but not all projects, *i.e.,* primarily when blower door tests reveal an excess of air leakage between 3 and 5 ACH. A well planned and built house should meet the 3 ACH standard, and the additional costs of caulking and other sealing techniques are limited. To the extent a blower door test reveals leaks between 3 and 5 ACH, the additional cost will typically involve filling envelope gaps with caulk and other materials which are not costly. It may take some looking to find the gaps, but it shouldn't be hard to block the leaks. Greater care by builders during the framing, insulating and sealing processes will avoid having to go back and fix leaks.

On the other hand, residents will save money and experience other benefits by reducing the volume of air changes that have to be reheated, re-cooled or dehumidified. Retrofitting to achieve the same level of tightness after walls have been closed up could require going behind walls and would be much more difficult and costly to building owners than doing the job well during the construction phase. As noted in the Reason Statement, DOE/PNNL found that the 2012 IECC changes, including the air tightness standards, would save residents money year in and year out, on a life-cycle basis. DOE/PNNL, *National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf If the costs had outweighed the benefits of the 3.0 ACH leakage standard, the ICC could have raised the permissible leakage rate any time in the four cycles 2012-2021. It did not, and Virginia should no longer deny the benefits to occupants of newly constructed dwellings. (Although the data published by DOE/PNNL amply demonstrates that full compliance satisfies the statutory standards, more detailed data and analysis can be requested by DHCD from PNNL, if desired.)

EC-C407.6-21

VECC: C407.6 (New), R406.8 (New), N1106.8 (New)

Proponents: William Penniman (wpenniman@aol.com)

2018 Virginia Energy Conservation Code

Add new text as follows:

C407.6 Zero Energy Commercial Construction. Any commercial building constructed and marketed or otherwise held out to be a “zero energy” building or “net zero energy building” or made subject to an equivalent claim must satisfy the standards set forth in Appendix CC Zero Energy Commercial Building Provisions, in addition to any other energy efficiency and renewable energy standards that are applicable to such building. Written notice must be given to the permitting authority of the intent to market a building as a "zero energy" or "net zero energy." A building inspection and independent confirmation of compliance with Appendix CC must be conducted and supporting documentation must be submitted to demonstrate full compliance with Appendix CC. The building code official may require additional information, as appropriate, to demonstrate compliance. A written report certifying compliance or non-compliance with Appendix CC shall be delivered to the buyer or owner prior to building occupancy.

R406.8 Zero Energy Residential Construction. Any residential building constructed and marketed or otherwise held out to be a “zero energy” building or “net zero energy” or made subject to an equivalent claim must satisfy the standards set forth in Appendix RC Zero Energy Residential Building Provisions in addition to any other energy efficiency and renewable energy standards applicable to such construction or rehabilitation. Inspection and independent confirmation of compliance with Appendix RC must be conducted and documentation provided to confirm compliance with Appendix RC Zero Energy Residential Building Provisions. The building code official may require additional information, as appropriate, to demonstrate compliance. A written certification of compliance or non-compliance with the standards in Appendix RC shall be delivered to buyer prior to occupancy and shall be added to the permanent certificate required by R401.3.

N1106.8 Zero Energy Residential Construction.
Any residential building constructed and marketed or otherwise held out to be a “zero energy” building or “net zero energy” or made subject to an equivalent claim must satisfy the standards set forth in Appendix RC Zero Energy Residential Building Provisions in addition to any other energy efficiency and renewable energy standards applicable to such construction or rehabilitation. Inspection and independent confirmation of compliance with Appendix RC must be conducted and documentation provided to confirm compliance with Appendix RC Zero Energy Residential Building Provisions. The building code official may require additional information, as appropriate, to demonstrate compliance. A written certification of compliance or non-compliance with the standards in Appendix RC shall be delivered to buyer prior to occupancy and shall be added to the permanent certificate required by N1101.3.

Reason Statement: The 2021 IECC adds two appendices specifying the requirements for "zero energy" construction: "Appendix CC Zero Energy Commercial Building Provisions" and "Appendix RC Zero Energy Residential Building Provisions".

The purpose of this proposal is to activate the standards set forth in these two appendices by making them applicable and mandatory for any buildings constructed and sold, leased, or otherwise marketed or held out as being "zero energy" or "net zero energy" or equivalent labels. It does not require builders to go beyond the generally applicable terms of the 2021 IECC, but it protects buyers, residents and competing "zero energy" builders by assuring that buildings claimed to be "zero energy" actually meet recognized "zero energy" energy conservation standards set forth in the Code. The appendices are new and will be incorporated into Virginia's 2021 building code update.

There are many instances in which building code provisions are tied to the intended purpose or specific use of a building, which is also part of the marketing of that building. Achieving specific levels of performance (efficiency or otherwise) is also commonly required of new buildings whether separately advertised or simply assumed as part of building code compliance. Thus, there is nothing unreasonable about requiring a builder (a) to notify building officials in a permit application of an intent to market a building as "zero energy" or "net zero energy," (b) to subject the building to inspections and testing that confirm compliance with the code provisions, and (c) to provide written notification to the buyer or owner of the outcome of compliance tests. The phrase "or made subject to a similar claim" is to prevent a builder from trying to evade the standard by saying things like "it won't use any net energy" or "it will produce all the energy it needs".

Zero energy buildings are hugely valuable for residents and landlords because they eliminate energy costs of occupancy, over time, through a combination of enhanced energy efficiency and renewable energy. Such buildings are becoming increasingly popular, particularly since they cut both occupancy costs and pollution driving climate change. In reality, a shift to zero energy (net zero energy) housing will be critical to keeping global temperatures at levels that will prevent catastrophic climate harms. Given that new housing will operate for 70 or more years, it is vital that quality zero carbon construction begin sooner rather than later. Even though it does not mandate zero carbon construction, this proposal will at least establish minimum standards for such construction.

Resiliency Impact Statement: This proposal will increase Resiliency
This proposal will increase resiliency in several ways. Individual zero energy buildings and their occupants will be more resilient because they will (a) consume less energy, (b) produce zero-carbon renewable energy equal to or in excess of their energy needs, (c) retain heat or cooling during periods of utility outages, (d) be more capable of self-supplying electricity and possibly other energy during periods of utility outages, and (e) less exposed to economic harm from fluctuating energy prices. These are large resiliency benefits for residents in zero energy dwellings and their lenders or landlords.

This proposal will also increase resiliency for the public by reducing greenhouse gas emissions, reducing demands on utilities during critical supply and price periods and reducing risks of loan and lease defaults attributable to fluctuating energy prices.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This proposal does not require construction of zero energy buildings. It merely assures that buildings meet basic standards of construction and truth in advertising if they are built and sold or leased as "zero energy" or "net zero energy" buildings.

REC-R402.1.2 (1)-21

VECC: TABLE R402.1.2, TABLE R402.1.4; VRC: TABLE N1102.1.2 (R402.1.2), TABLE N1102.1.4 (R402.1.4); VCC: 1301.1.1.1, TABLE R402.1.2, TABLE R402.1.4

Proponents: Laura Baker (laura@reca-codes.com); Eric Lacey (eric@reca-codes.com)

2018 Virginia Energy Conservation Code

Revise as follows:

TABLE R402.1.2 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR [b]	SKYLIGHT [b] *U*-FACTOR	GLAZED FENESTRATION SHGC [b, e]	CEILING R-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE [i]	FLOOR *R*-VALUE	BASEMENT [c] WALL *R*-VALUE	SLAB [d] *R*-VALUE & DEPTH	CRAWL SPACE [c] WALL *R* VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.30	0.55	0.25	38	20 or 13 + 5 ci or 0 + 15ci[h]	8/13	19	5/13 [f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	30 or 20 + 5ci or 13 + 10ci or 0 + 20ci ~~15 or 13+1~~ [h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	30 or 20 + 5ci or 13 + 5 ci or 0 + 20ci [h]	13/17	30 [g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20+5 [h] or 13+10 [h]	15/20	30 [g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20+5 [h] or 13+10 [h]	19/21	38 [g]	15/19	10, 4 ft	15/19

NR = Not Required.

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall.

"15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. Alternatively, insulation sufficient to fill the framing cavity and providing not less than an *R*-value of R-19.

h. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.

i. Mass walls shall be in accordance with Section R402.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.

TABLE R402.1.4 EQUIVALENT U-FACTORS [a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR [b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.030	0.060	0.098	0.047	0.091 [c]	0.136
4 except Marine	0.32	0.55	0.026	0.0~~79~~ 45	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.026	0.0~~60~~ 45	0.082	0.033	0.050	0.055
6	0.30	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.055

2018 Virgina Residential Code

Revise as follows:

TABLE N1102.1.2 (R402.1.2) INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c] WALL *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13 + 5ci[h] or 0 + 15ci	8/13	19	5/13[f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	30 or 20 + 5ci or 13 + 10ci or 0 + 20ci ~~15 or 13 + 1~~[h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	30 or 20 + 5ci or 13 + 10ci or 0 + 20ci~~5~~[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20 + 5[h] or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

For SI: 1 foot = 304.8 mm.

NR = Not Required.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

   Exception: In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "10/13" means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall. "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation on the interior of the basement wall. Alternatively, compliance with "15/19" shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation shall not be required in warm-humid locations as defined by Figure N1101.7 and Table N1101.7.

g. Alternatively, insulation sufficient to fill the framing cavity providing not less than an *R*-value of R-19.

h. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+5" means R-13 cavity insulation plus R-5 continuous insulation.

i. Mass walls shall be in accordance with Section N1102.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

TABLE N1102.1.4 (R402.1.4) EQUIVALENT U-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*- FACTOR	SKYLIGHT *U*- FACTOR	CEILING *U*- FACTOR	FRAME WALL *U*- FACTOR	MASS WALL *U*- FACTOR[b]	FLOOR *U*- FACTOR	BASEMENT WALL *U*- FACTOR	CRAWL SPACE WALL *U*- FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.32	0.55	0.026	~~0.079~~ 0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.026	~~0.060~~ 0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.055

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section N1102.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zone 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure N1101.7 and Table N1101.7, the basement wall *U*-factor shall not exceed 0.360.

2018 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the International Energy Conservation Code (IECC). The following changes shall be made to the IECC:

~~18. Change the wood frame wall *R*-value categories for Climate Zone 4 (Except Marine) in Table R402.1.2 to read:~~

~~19. Change the frame wall *U*-factor categories for Climate Zone 4 (Except Marine) in Table R402.1.4 to read:~~

~~**TABLE R402.1.2 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]**~~

~~**CLIMATE ZONE**~~	~~**WOOD FRAME WALL *R*-VALUE**~~
~~4 except Marine~~	~~15 or 13 + 1[h]~~

~~**TABLE R402.1.4 EQUIVALENT U-FACTORS[a]**~~

~~**CLIMATE ZONE**~~	~~**FRAME WALL *U*-FACTOR**~~
~~4 except Marine~~	~~0.079~~

Reason Statement: This proposal improves the comfort, efficiency, and resiliency of Virginia homes by improving the wall insulation requirements. It will also make Virginia's energy code consistent with the 2021 IECC requirements for wall insulation. The U.S. DOE found the 2021 IECC to be cost-effective for Virginia (*see* https://www.energycodes.gov/sites/default/files/2021-07/VirginiaResidentialCostEffectiveness_2021.pdf), and improvements to the thermal building envelope are important to the long-term efficiency and cost-effectiveness of new buildings. Using the U.S. Department of Energy methodology for reviewing code change proposals, and using BEopt modeling software, our analysis found that an improvement from R-15 to R-20+5 in wall insulation will result in a 13.1% improvement in efficiency, and a simple payback period of less than 5 years. Wall insulation is easiest (and most cost-effective) to install during construction. Given that there may only be limited opportunities to upgrade the walls in the future, it is important to construct well-insulated walls from the very beginning. Better-insulated buildings are clearly an investment in Virginia's energy future. We recommend maintaining consistency with the 2021 IECC requirements.
The wall insulation R-values in the 2021 IECC do not require the use of any specific product and can be achieved with either 2X4 or 2X6 wall construction. The values in the prescriptive R-value table are only a few of many different options. For additional wall insulation options, builders can use one of several compliance paths, each of which provides multiple options and combinations for meeting the code requirements:

- The U-factor alternative table (R402.1.2)
- The Total UA Alternative (R402.1.5)
- U.S. DOE's REScheck software (www.energycodes.gov)
- The Simulated Performance Alternative (R405)
- The Energy Rating Index (R406)

This proposal also updates the equivalent U-factors to be consistent with the 2021 IRC/IECC, which is important for builders and design professionals who intend to use DOE's free REScheck compliance software or other energy rating programs. We recommend that Virginia adopt equivalent U-factor values that will be consistent with the latest version of the IECC, both to maximize cost-effective energy efficiency and to improve the resiliency of every new home built in the Commonwealth.

Resiliency Impact Statement: This proposal will increase Resiliency
This proposal will increase resiliency in Virginia's residential buildings. The International Code Council published a white paper titled *The Important Role of Energy Codes in Achieving Resilience* regarding the role of energy efficiency in resiliency. *See* https://www.iccsafe.org/wp-content/uploads/19-18078_GR_ANCR_IECC_Resilience_White_Paper_BRO_Final_midres.pdf. Specifically, the ICC found that increased insulation requirements support passive survivability and reduce energy burdens on low-income families, grid impacts by reducing energy demand, ice-dams, and condensation, limiting mold and mildew.

Cost Impact: The code change proposal will increase the cost of construction
The improvement in wall insulation will increase initial construction cost, but is clearly cost-effective to the homeowner. Using the U.S. Department of Energy methodology for evaluating code change proposals, and using BEopt modeling software, we estimated that the average incremental increase in cost for climate zone 4 is $735.00. The average improvement in energy cost savings is 13.1%, which means simple payback is achieved within 4.4 years, on average. Obviously, results will vary based on which compliance option is selected by the builder, unique characteristics of each building, and so on. But given that walls are unlikely to be altered over the expected 70-100 year useful lifetime of the building, wall insulation is a vitally important measure to incorporate at the time of construction.

REC-R402.1.2 (2)-21

VECC: TABLE R402.1.2, TABLE R402.1.4

Proponents: William Penniman (wpenniman@aol.com)

2018 Virginia Energy Conservation Code

Revise as follows:

TABLE R402.1.2 INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT [a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR [b]	SKYLIGHT [b] *U*-FACTOR	GLAZED FENESTRATION SHGC [b, e]	CEILING R-VALUE	WOOD FRAME WALL *R*-VALUE	MASS WALL *R*-VALUE [i]	FLOOR *R*-VALUE	BASEMENT [c] WALL *R*-VALUE	SLAB [d] *R*-VALUE & DEPTH	CRAWL SPACE [c] WALL *R* VALUE
1	NR	0.75	0.25	30	13	3/4	13	0	0	0
2	0.40	0.65	0.25	38	13	4/6	13	0	0	0
3	0.32	0.55	0.25	38	20 or 13+5 or 0+15ci [h]	8/13	19	5/13 [f]	0	5/13
4 except Marine	0.32	0.55	0.40	49	~~15 or 13+1~~ 30 or 20+5ci or 13+10ci or 20ci [h]	8/13	19	10 /13	10, 2 ft	10/13
5 and Marine 4	0.30	0.55	NR	49	~~20 or 13+5~~30 or 20+5ci 13+10ci or 20ci [h]	13/17	30 [g]	15/19	10, 2 ft	15/19
6	0.30	0.55	NR	49	20+5 [h] or 13+10 [h]	15/20	30 [g]	15/19	10, 4 ft	15/19
7 and 8	0.30	0.55	NR	49	20+5 [h] or 13+10 [h]	19/21	38 [g]	15/19	10, 4 ft	15/19

NR = Not Required.

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 1 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation on the interior of the basement wall.

“15/19” means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. Alternatively, compliance with “15/19” shall be R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. Alternatively, insulation sufficient to fill the framing cavity and providing not less than an *R*-value of R-19.

h. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, “13+5” means R-13 cavity insulation plus R-5 continuous insulation.

i. Mass walls shall be in accordance with Section R402.2.5. The second R-value applies where more than half of the insulation is on the interior of the mass wall.

TABLE R402.1.4 EQUIVALENT U-FACTORS [a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR [b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
1	0.50	0.75	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.030	0.084	0.165	0.064	0.360	0.477
3	0.32	0.55	0.030	0.060	0.098	0.047	0.091 [c]	0.136
4 except Marine	0.32	0.55	0.026	~~0.079~~ 0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.026	~~0.060~~ 0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	0.026	0.045	0.057	0.028	0.050	0.055

Reason Statement: The purpose of this proposal is to have Virginia adopt the full wall insulation efficiency requirements of the 2021 IECC. These updates are critical since Virginia is still implementing the 2009 wall insulation standards, making it a *more than a decade* behind the IECC. Continuing to lag years behind the IECC is inconsistent with Virginia law governing building codes. Sections 36-99A and 36-99B of the Virginia Code require the USBC to protect the public, to adhere to recognized standards of energy conservation and water conservation, and to reduce construction and rehabilitation costs only to the extent the results are consistent with the recognized code standards. ("The provisions of the Building Code and modifications thereof shall be such as to protect the health, safety and welfare of the residents of the Commonwealth, provided that buildings and structures should be permitted to be constructed, rehabilitated and maintained at the least possible cost consistent with recognized standards of health, safety, energy conservation and water conservation….") H2227, which was enacted in 2021, specifically calls for efficiency standards Virginia's code to be "at least as stringent" as the most current IECC.
Residents' welfare is plainly harmed by failing to adopt the 2021 IECC building efficiency standards. The incremental costs of construction are more than outweighed by the energy cost savings and other benefits to residents from tighter, more energy-efficient construction. The 2021 IECC incorporates wall insulation changes in addition to those made in the 2012 IECC. DOE/PNNL found, years ago, that the 2012 IECC would save residents money every year compared to the 2009 standards even considering the impacts of construction costs on residents' full occupancy costs.[1] In 2021, it found that updating to the 2021 IECC would save residents money compared to the 2012 IECC standards. Its findings support 2021 IECC compliance both nationally and for Virginia.[2] DOE/PNNL's lifecycle cost-benefit analysis considered all the costs of ownership, including the mortgage and tax impacts attributable to incremental construction costs and the savings from reduced energy usage.

Structural energy efficiency measures, including wall insulation, are extremely important in dwellings that have an expected life of 70 years or more.[3] They will benefit all residents whether owners or tenants. The ongoing burden of inefficient construction harms everyone, but it particularly harms low-income and moderate-income residents.[4]
Other benefits to residents from implementing the 2021 IECC envelope insulation (and leakage) standards include (a) health benefits, (b) added comfort, (c) greater resilience, and (d) avoidance of future need for more costly wall retrofits. The general public would also benefit from implementing the 2021 IECC envelope standards by (i) reducing climate harms from carbon pollution, (ii) reducing other health impacts from fossil fuel pollution, (iii) reducing overall utility bills by avoiding peak and annual fuel costs and minimizing facility construction costs.

It is vital to implement the IECC's envelope insulation standards during initial construction. The cost of *retrofitting* insulation in walls is much higher because it would require removing, replacing and refinishing walls. As a result, retrofitting to achieve the 2021 requirements for new construction is less likely to be undertaken. Indeed, the Base Document would continue a practice of not requiring any insulation upgrades unless walls are opened for some other purpose. Thus, residents and the public would suffer long-term harm from continuing to permit builders to under-insulate walls.
To make matters worse, the public and utility customers are paying for efficiency upgrades of some dwellings in order to offset poor efficiency in existing buildings. Virginia is on-course to spend over $1 billion, this decade, on improving energy efficiency primarily in existing dwellings--vastly more than it would have cost to build the housing well in the first place. There is no basis for assuming that utilities will continue to spend ratepayer money to make up for construction practices that are not "at least as stringent" as those in the latest IECC.
In sum, it would harm both residents and the public to continue implementing outdated building code standards that results from construction standards that are not at least as stringent as the 2021 IECC.
[1] DOE/PNNL, *National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf
[2] https://www.energycodes.gov/national-and-state-analysis
[3] Alliance to Save Energy, https://www.ase.org/buildings
[4] The VA Poverty Law Center reports that "On average Virginia households experience an already higher than average electricity burden of 3.1%, compared to a national average of 2.7%. 'Electricity burden' is the percentage amount of your household income that is spent on electricity costs. Financial advisors agree that an average of 6% for your entire energy burden is 'affordable.' Virginian's higher than average electricity burden is unaffordable for over 75% of Virginia's households." https://vplc.org/electricity-burden-and-the-myth-of-virginias-rate-utopia/

Resiliency Impact Statement: This proposal will increase Resiliency
The proposed measures will help to enhance resiliency by protecting residents, reducing energy demand, helping to mitigate climate impacts and preparing Virginia's buildings and economy for a future that requires the least energy usage and energy-driven pollution possible.
Improving envelope efficiency will help residents and communities to withstand power outages from storms or other causes. During power outages, buildings with tighter, better insulated envelopes remain comfortable much longer because more efficient envelopes better maintain indoor heat in cold periods and indoor coolness in warm periods. Reducing demand through greater building efficiency will reduce burdens on utilities. That will help utilities to hold down operating and capital costs, in addition to helping them better cope with storms and other difficulties. All rate payers and the entire community benefits from this greater resilience and lower costs.

Reduced demand for energy will also mitigate climate change impacts. Climate change is already harming Virginia, and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane). Growing climate dangers include harms to communities, infrastructure, people, property and the economy from rising seas, worsening storms and more severe rainfall events. These harms extend well beyond coastal communities. Growing dangers also include rising atmospheric and water temperatures that threaten worsening heat-related illnesses, limits on economic activity, agriculture, fisheries, and our natural heritage. The likelihood of mitigating and of recovering from those harms declines the longer we delay maximizing energy savings and minimizing GHG pollution. Sensible investments now in energy conserving measures will reduce future rehabilitation and adaptation costs, as well as future harms.

Cost Impact: The code change proposal will increase the cost of construction
Adopting these long-overdue energy saving measures will add marginally to construction costs, but will provide greater long-term savings to residents and mitigate costs to the public generally, as outlined in the Reason and Resliency Statements. DOE/PNNL calculate that implementing the 2021 IECC will save Virginia residents $8,376 on a lifecycle basis, with positive cash flow to residents annually. DOE/PNNL, *Cost-Effectiveness of the 2021 IECC for Residential Buildings in Virginia* (July 2021), https://www.energycodes.gov/national-and-state-analysis DOE/PNNL analysis showed that the 2012-2018 IECC standards, including for wall insulation, also would save residents thousands of dollars -- if Virginia had adopted them on a timely basis. DOE/PNNL, *National Energy Cost Savings for New Single and Multifamily Homes, A Comparison of the 2006, 2009, and 2012 Editions of the IECC*, https://www.energycodes.gov/sites/default/files/documents/NationalResidentialCostEffectiveness.pdf

In other words, residents will experience net annual and monthly costs savings for many years compared to living in dwellings built based on pre-2012 IECC standards. Since the benefits to residents from full compliance with the 2021 IECC clearly outweigh the incremental construction costs, the statutory standards to adopt standards "at least as stringent" as the 2021 IECC have been more than satisfied. (Although the data published by DOE/PNNL amply demonstrates that full compliance satisfies the statutory standards, more detailed data and analysis can be requested by DHCD from PNNL, if desired.)

REC-R402.4.1.2-21

VECC: R402.4.1.2, R402.4.1.3 (New); VRC: N1102.4.1.2, N1102.4.1.3 (R402.4.1.3) (New); VCC: 1301.1.1.1

Proponents: Laura Baker (laura@reca-codes.com); Eric Lacey (eric@reca-codes.com)

2018 Virginia Energy Conservation Code

Revise as follows:

R402.4.1.2 Testing. The building or *dwelling unit* shall be tested ~~and verified as having an~~ for air leakage . ~~rate not exceeding five air changes per hour in *Climate Zone* 4.~~ The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of the dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official* , testing shall be conducted by an *approved* third party . 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.~~ envelope have been sealed .

~~**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.~~

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, conditioned spaces in accordance with Sections R402.2.12 and R402.3.5, as applicable.

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; and
6. Supply and return registers, if installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units* , an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779, or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single and multiple-family building dwelling units.

2. Buildings or dwelling units that are 1,500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code* , as applicable, or with other *approved* means of ventilation.

Add new text as follows:

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 house in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.

2018 Virgina Residential Code

Revise as follows:

N1102.4.1.2 (R402412) Testing. The *building* or dwelling unit shall be tested ~~and verified as having an~~ for air leakage ~~rate not exceeding five air~~

~~changes per hour in Climate Zone 4 4.~~ . The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 m^3 /(s x m^2)] of the dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779, or ASTM E1827 and reported at a pressure of 0.2 inches w.g. (50 Pa). Where required by the *code official* , testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the ~~building building~~ code 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* have been sealed.

> ~~**Note:** Should additional sealing be required as a result of the test, consideration may be given to the issuance of temporary certificate of occupancy in accordance with Section 116.1.1.~~
>
> **Exception:** For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, conditioned spaces in accordance with Sections R402.2.12 and R402.3.5, as applicable.

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; and
6. Supply and return registers, if installed at the time of the test, shall be fully open.

> **Exception:** When testing individual *dwelling units* , an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 m^3 /(s x m^2)] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779, or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:
>
> 1. Attached single and multiple-family building dwelling units.
>
> 2. Buildings or dwelling units that are 1,500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code* , as applicable, or with other *approved* means of ventilation.

Add new text as follows:

N1102.4.1.3 (R402.4.1.3) Leakage rate.. When complying with Section N1101.2.1 (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 0, 1, and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section N1102.4.1.2 (R402.4.1.2).

2018 Virginia Construction Code

Revise as follows:

1301.1.1.1 Changes to the International Energy Conservation Code (IECC). The following changes shall be made to the IECC:

~~23. Change Section R402.4.1.2 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 in Climate Zone 4. 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; and~~
6. ~~Supply and return registers, if installed at the time of the test, shall be fully open.~~

Reason Statement: The purpose of this code change proposal is to improve efficiency and maintain compliance flexibility for code users by modifying the air leakage testing requirements to be consistent with the 2021 IECC. Specifically, the proposal improves the baseline envelope tightness requirement from 5.0 ACH50 to 3.0 ACH50, but adds a performance path trade-off option for air tightness up to 5.0 ACH50, as long as the efficiency losses are accounted for. The proposal also adds a cfm/sq.ft. compliance option for attached dwelling units and small single-family dwelling units in order to provide more options for builders.
This proposal includes a cost-effective incremental improvement from Virginia's 2018 USBC by tightening the air leakage rate from 5.0 ACH50 to 3.0 ACH50. Based on an analysis of this code change using the U.S. Department of Energy's methodology and using BEopt modeling software, we estimate that this improvement will achieve 9.2% lower energy costs, with a simple payback period of less than 2 years. Results will obviously vary based on the characteristics and size of the home, as well as how much additional work is necessary to achieve the lower leakage rates, but given the long-term benefits of a tighter envelope -- lower energy costs, more efficient system operation, better indoor air quality, etc. -- this improvement is well-justified.

The prescriptive air leakage rate of 3.0 ACH50 has been in the code since the 2012 edition of the IECC. In the 2018 USBC update, Virginia implemented mandatory blower door testing at a rate of 5.0 ACH50, which was short of the full requirement in the 2018 IECC. Now that builders have had some additional experience with mandatory blower door testing and sealing techniques, we believe it is reasonable to further improve the requirements. At the same time, for projects that are not yet able to achieve envelope air tightness of 3.0, there is an alternative to comply via the performance path or Energy Rating Index, which will allow leakage rates up to 5.0 ACH50. This proposal also clarifies the maximum air leakage rates as 3.0 and 5.0 air changes per hour. While most code users understand the maximum air leakage rates as already being at 3.0 and 5.0 changes per hour, the addition of another digit will pre-empt any "round up" vs. "round-down" arguments from code users, providing additional support for building code officials who are simply trying to enforce the code. This part of the proposal does not change any actual requirements, but rather provides clarification and reduces inconsistency and confusion.

Resiliency Impact Statement: This proposal will increase Resiliency
This proposal will increase the resiliency of homes. A properly sealed home will help maintain better indoor air quality and improve the long-term durability of the home. It will also reduce the volatility of indoor temperature swings and maintain more livable conditions during power outages due to natural emergencies.

Cost Impact: The code change proposal will increase the cost of construction
For buildings not already achieving 3 ACH50 or less, this code change will likely increase construction costs. Based on an analysis using the U.S. DOE methodology for reviewing code changes, and using BEopt modeling software, we estimate that the average marginal cost increase of this proposal is $144. However, our analysis also showed a 9.2% improvement in overall efficiency, which would result in a simple payback of less than 2 years. We also note that for any project for which the prescriptive requirement may be infeasible, builders will have the flexibility to meet the

current air leakage requirement from the 2018 USBC using tradeoffs under another compliance path.

REC-R403.3.3-21

VRC: N1103.3.3, N1103.3.4 (R403.3.4), N1103.3.5

Proponents: Eric Lacey (eric@reca-codes.com)

2018 Virgina Residential Code

Revise as follows:

N1103.3.3 (R40333) Duct testing (Mandatory). Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1-inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. All registers shall be taped or otherwise sealed during the test.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1-inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exception: A duct air leakage test shall not be required ~~where the ducts and air handlers are located entirely within the *building thermal envelope*.~~ for ducts serving heating, cooling or ventilation systems that are not integrated with ducts serving heating or cooling systems.

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.

N1103.3.4 (R403.3.4) Duct leakage (Prescriptive). The total leakage of the ducts, where measured in accordance with Section R403.3.3, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to ~~4~~ 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to ~~3~~ 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.
2. Postconstruction test: Total leakage shall be less than or equal to ~~4~~ 4.0 cubic feet per minute (113.3 L/ min) per 100 square feet (9.29 m^2) of conditioned floor area.
3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.

N1103.3.5 (R40335) Building cavities (Mandatory). ~~(Section deleted.)~~ *Building* framing cavities used as ducts or plenums shall comply with VRC Section M1601.1.1.

Reason Statement: This proposal updates the code provisions related to duct testing to be consistent with the 2021 IECC. A few of the changes proposed (such as the requirement that building cavities not be used as ducts or plenums) have been in the IECC for several editions; others (such as the addition of a duct test for ducts inside conditioned space) were added in the 2021 IECC update. It incorporates the changes brought about by proposals RE112-19, RE114-19, and RE118-19.

This proposal establishes a maximum level of allowable duct leakage -- regardless of the location of the ducts. From the proponent's original reason statement in proposal RE115:

"The purpose of this code change proposal is to help ensure long-term energy savings, occupant comfort and promote good building quality by establishing a maximum level of duct leakage permitted as a trade-off backstop for duct tightness. We propose a backstop that would still permit substantial flexibility – double the allowable leakage rate as the prescriptive requirement -- but that would establish a “worst case scenario” for all tested homes in all compliance paths.There is currently no upper limit on duct leakage in the IECC. In the 2012 IECC, all ducts (except those in conditioned space) were required on a mandatory basis to meet the prescriptive levels. The mandatory nature of the requirement was removed in 2015, allowing duct tightness to be fully traded off for other efficiency measures. We believe some trade-off is acceptable, but that a minimum level of duct tightness is necessary to ensure some reasonable level of duct performance occurs in the home. When ducts are excessively leaky, there is no assurance that conditioned air is provided where it is needed for adequate comfort. The failure to properly distribute conditioned air is likely to result in excess energy usage when the occupants adjust the thermostat to counter an inadequate distribution of conditioned air. Many of the intended benefits of high-performance homes are negated if occupants are uncomfortable and adjust the thermostat in response."

We note that this proposal (RE115) was recommended for approval by the IECC-Residential Committee and no public comments were filed, meaning that no stakeholders opposed its incorporation into the 2021 IECC.This proposal also removes the exception from duct leakage testing for systems located entirely within the building envelope. This proposal (RE112) was recommended for approval by the IECC-Residential Committee, and then was approved by over 87% of the Governmental Member Voting Representatives at ICC for inclusion in the 2021 IECC. From the proponent's original reason statement in proposal RE112: The purpose of this code change proposal is to help ensure occupant comfort, proper heating and cooling system performance, and resulting long-term energy savings by requiring a duct leakage test for all new homes, including homes with all ducts inside conditioned space. This action will also help reduce the likelihood of builder callbacks for poorly-functioning, uncomfortable HVAC systems. The IECC currently exempts homes from duct testing requirements where the air handler and all ducts are located inside conditioned space. Although moving all ducts inside conditioned space may have a positive impact on energy efficiency overall, this practice alone cannot guarantee that the ducts will be tight enough to deliver conditioned air to all occupied areas of the home. Uncomfortable occupants commonly adjust thermostat settings to counteract the effect of poor delivery of conditioned air, leading to huge losses in energy efficiency. And these homes are at far greater risk for builder callback. This proposal will improve building quality and keep occupants more comfortable by requiring a duct test for all new homes, although the allowable leakage rate will be set at twice the prescriptive rate when all ducts are located inside conditioned space.Duct leakage rates can be extremely high when ducts are not tested. We do not believe that builders intentionally cut corners in duct sealing when they know that the system will not be tested. However, without an objective test as a means of quality assurance, even careful builders may not be aware of missed connections or poor sealing. In a recent DOE field study of residential homes in Kentucky, homes received duct leakage tests even where all supply and return ducts were located inside conditioned space. The results were striking – **of the 24 homes tested (that would have qualified for the test exemption under the IECC), all 24 homes had higher leakage rates than the 2018 IECC requirement. Tested duct leakage for these homes averaged 18.5 cfm/sq.ft., with individual homes ranging from 6.26 cfm/sq.ft. to as high as 40.36 cfm/sq.ft.** *See* https://www.energycodes.gov/compliance/energy-code-field-studies. We note that 40 other homes in the same study were required to be tested (because at least some ducts were located outside conditioned space), and these homes achieved leakage rates of 9.7 cfm/sq.ft., on average – roughly half the leakage rate of homes that qualified for the exemption. Obviously, this is a small sample size, but the Field Studies found similar results in Pennsylvania, where “exempt” homes (with all ducts inside conditioned space) averaged almost 31 cfm/sq.ft. leakage, while homes required to be tested averaged almost 18 cfm/sq.ft. leakage. Although the results vary across the states sampled, these results point to a shortcoming in the IECC’s “complete exemption” approach to homes with all ducts inside conditioned space.

The concept of requiring a test for all new homes is not new. DOE’s Building America Program recommends that “[e]ven in conditioned space, ducts should be insulated to reduce the risk of condensation and mold. They should be tightly sealed and tested for leakage.” *See* https://www.energy.gov/sites/prod/files/2014/01/f6/1_1g_ba_innov_ductsconditionedspace_011713.pdf. Likewise, the International Association of Certified Home Inspectors recommends that ducts be located entirely within conditioned space and tested to ensure air tightness. Air leakage rates at air handlers, even when all ducts are located in conditioned space, can lead to significant reduction in comfort, leading homeowners to adjust the thermostat and significantly increase energy use. *See* https://www.nachi.org/inspecting-hvac-cabinet-seams-air-leakage-sealing.htm.

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency

Cost Impact: The code change proposal will increase the cost of construction
For homes that would not have been required to test ducts (because they are located inside conditioned space), this proposal will result in a construction cost increase of about $200 for a duct test. However, the proposal substantially reduces homeowner risk, because the test will objectively verify that the heating and cooling systems are operating as intended, and will provide an opportunity for the builder to correct any mistakes. The test will also reduce the likelihood of a builder callback.

REC-R1104.2-21

VRC: N202 (New), N1104.2 (New), N1104.2.1 (New); VECC: R202 (N202) (New), R404.2 (N1104.2) (New), R404.2.1 (N1104.2.1) (New)

Proponents: William Penniman (wpenniman@aol.com)

2018 Virgina Residential Code

Add new text as follows:

N202 General Definitions. Add following definitions:
ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, electric motorcycles and the like, which is primarily powered by an electric motor that draws current from a rechargeable storage battery. A "plug-in hybrid" is a type of electric vehicle which relies on a combination of a rechargeable storage battery and another source of motive power.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the Electric Vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or charging apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.

EVSE INSTALLED SPACE. A designated parking space which is provided with EVSE, including an energized branch circuit with at least 40-ampere, 208/240 volts capacity that connects electric panel capacity to charging apparatus located within three feet of the parking space.

EV CAPABLE SPACE. A designated parking space which is provided with reserved electrical panel space to support a minimum 40-ampere, 208/240-volt branch circuit for EVSE and with an adequately-sized raceway for such a branch circuit from the panel to a clearly identified location within three feet of the parking space, to support future EVSE.

EV READY SPACE. A designated parking space which is provided with reserved electric panel capacity and space to serve at least a 40-ampere, 208/240-volt dedicated branch circuit to electrify EVSE. The circuit shall terminate in a suitable termination point, such as a power outlet, junction box, or EVSE apparatus, located within three feet of the parking space.

N1104.2 Electric Vehicle Readiness. New construction shall install or facilitate future installation and use of Electric Vehicle Supply Equipment (EVSE) in accordance with the National Electrical Code (NFPA 70) and N1104.2.1. **Exception:** EV supportive spaces are not required where no parking spaces are provided to residents.

N1104.2.1 EV Ready Installations. For each dwelling unit, provide at least one EV Ready Space or EVSE Installed Space in a garage or outdoor parking area. Additional EVSE Ready or EVSE Installed or EV Capable Spaces may be provided. The branch circuit for an EV Ready Space shall be identified as "EV Ready" in the service panel or subpanel directory, and the termination location shall be marked as "EV Ready". The outdoor conduit for an external EV Ready Space, EVSE Installed Space or EV Capable Space shall be located underground and be protected from water. Construction documents shall identify the location and capacity of branch circuits and raceways and the document the adequacy of electric panel and service capacity.

2018 Virginia Energy Conservation Code

Add new text as follows:

R202 (N202) General Definitions.
Add the following definitions;
ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, electric motorcycles and the like, which is primarily powered by an electric motor that draws current from a rechargeable storage battery. A "plug-in hybrid" is a type of electric vehicle which relies on a combination of a rechargeable storage battery and another source of motive power.
ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the Electric Vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or charging apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.
EVSE INSTALLED SPACE. A designated parking space which is provided with EVSE, including an energized branch circuit with at least 40-ampere, 208/240 volts capacity that connects electric panel capacity to charging apparatus located within three feet of the parking space.
EV CAPABLE SPACE. A designated parking space which is provided with reserved electrical panel space to support a minimum 40-ampere, 208/240-volt branch circuit for EVSE and with an adequately-sized raceway for such a branch circuit from the panel to a clearly identified location within three feet of the parking space, to support future EVSE.
EV READY SPACE. A designated parking space which is provided with reserved electric panel capacity and space to serve at least a 40-ampere, 208/240-volt dedicated branch circuit to electrify EVSE. The circuit shall terminate in a suitable termination point, such as a power outlet, junction box, or EVSE apparatus, located within three feet of the parking space.

R404.2 (N1104.2) Electric Vehicle Readiness. New construction shall install or facilitate future installation and use of Electric Vehicle Supply Equipment (EVSE) in accordance with the National Electrical Code (NFPA 70) and R404.2.1. **Exception:** EV supportive spaces are not required where no parking spaces are provided to residents.

R404.2.1 (N1104.2.1) EV Ready Installations. For each dwelling unit, provide at least one EV Ready Space or EVSE Installed Space in a garage or outdoor parking area. Additional EVSE Ready or EVSE Installed or EV Capable Spaces may be provided. The branch circuit for an EV Ready Space shall be identified as "EV Ready" in the service panel or subpanel directory, and the termination location shall be marked as "EV Ready". The outdoor conduit for an external EV Ready Space, EVSE Installed Space or EV Capable Space shall be located underground and be protected from water. Construction documents shall identify the location and capacity of branch circuits and raceways and the document the adequacy of electric panel and service capacity.

Reason Statement: This provision is designed to provide electric charging readiness for the growing use of electric vehicles (EVs) and to meet the essential need to offer at-home charging to residents many of whom own EVs or will own EVs in the next few years. It is designed to minimize costs through phasing of EV development, with an emphasis on installing infrastructure during initial construction. Parking provided for one and two family dwellings and townhouses will only require the basic wiring and panel capacity of a single parking space. The owner can add the charger or outlet when needed. The capacity of the EV Ready circuit is at least 40 Amp, 208-240 Volts (adequate for what is commonly called "Level 2" charging), which is sufficient for timely vehicle charging. (Nothing is required if parking spaces are not provided to residents.)

The proposal will benefit residents and the public, saving money and cutting pollution. Providing access to home charging is important as a matter of practicality, money saving, a cleaner environment and equity. As a practical matter, EV charging takes time and is mostly done using at-home chargers. EVSE Ready spaces afford the ability to install "Level 2" chargers assures the ability to achieve a full battery charge overnight, providing users' range confidence and reducing costs by charging during utilities' off-peak hours. A builder may choose to add the charger to create an EVSE Installed space. (The developer may also installed additional EV Capable Spaces which only require the raceway capacity for Level 2 charging.)

EVs save money on fuel and maintenance. Annual savings were estimated at up to $1900--before gas prices jumped over $4/gallon. [1] While all EV users will benefit from fuel and maintenance savings, rural users are at the higher end of the potential savings because they tend to use more fuel for driving, and costs. All will also benefit by reducing the inconvenience of routine oil changes and other maintenance. Although the purchase cost of EVs is currently higher than the low end of vehicles with combustion engines, the purchase price is expected to fall as competition grows and, more importantly, the EV savings in fuel and maintenance costs more than pay for the initial price difference over time.

As more fully discussed in the Resiliency discussion, mitigation of climate change and air pollution generally are strong additional reasons to facilitate the shift to EVs. While EV sales and leases are growing due to their operating cost savings and other operating benefits, they will continue to grow in importance as climate risks encourage (or compel) shifting to vehicles that do not emit pollution. Vehicles are Virginia's largest source of carbon-dioxide emissions from fossil fuel combustion.[2] Even based on today's mix of generation in Virginia, DOE estimates that EVs would reduce CO_2 emissions by roughly two-thirds compared to vehicles combusting gasoline.[3] Emissions from generation that supplies EVs will decline more as utilities' zero-carbon renewable energy replaces fossil-fuel generation. EVs' direct emissions are non-existent, which also has substantial health and pollution benefits compared to gasoline or diesel vehicles, which is particularly important to low-income residents who are disproportionately impacted by air pollution from traditional vehicles. The harms to Virginians from climate change are present now and growing faster the longer we fail to slash emissions of CO_2. methane and other greenhouse gases.
At-home charging increases EV charging during off-peak periods, which opens the door to lower off-peak rates for users and to a reduction of electric rates to all utility customers.[4]

There is a national goal to have 50% of new vehicles to be EVs by 2030.[5] Major vehicle manufacturers have committed to shift production to EVs over the next 10 years with a number of manufactures committing to shift to 100% EV production in the next 5-10 years.[6]At-home charging in conjunction with single or multifamily parking is particularly important to meeting the needs of EV owners and to encourage charging during utilities' off-peak periods. According to research by JD Power, "80% of EV charging is done at home—almost always overnight—or while a car is parked during the workday" and EV users strongly prefer Level 2 (220/240V) charging. [7] The capability for at-home charging will substantially reduce barriers to EV adoption that arise from the inconveniences that EV charging is slower than pumping gasoline, the public infrastructure for charging is still limited, and drivers have limited ability to take advantage of off-peak rates without home-charging.Already Ford is advertising that its F-150 EV pickup will be able to provide back-up power for households. Going forward, utilities may get the added benefit of being able to draw on the batteries of parked electric vehicles in order meet peak demands and balance fluctuating loads.
Installing the wiring and basic infrastructure during construction when walls are open and workers are present is much cheaper than retrofitting which may damage wall board and require more difficult extensions of wiring. Experience shows that installing a simple 220V/40 Ampere branch circuit (comparable to a dryer or stove outlet) for "Level 2" EV charging, in a garage or outside close to parking spaces (e.g., on a wall near a single-family driveway), will enable an EV owner to reliably charge an EV at home, scheduling it at night or otherwise outside the utilities peak demand period for the lowest rates. The presence of the wiring from the beginning would permit low-cost installation of a different charging system preferred by the EV owner. Failure to install the EV during infrastructure will create barriers to EV adoption and raise long-term costs to residents.

.[1] *See* Consumer Reports, "EVs Offer Big Savings Over Traditional Gas-Powered Cars" (October 2020); Union of Concerned Scientists, https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles (up to $1900/year savings for rural EV owners); https://augustafreepress.com/deq-launches-clean-air-communities-program-aimed-at-driving-investment-in-electric-vehicle The police department of Westport Connecticut achieved operating and maintenance savings of over $17,000 in its first year of using a Tesla Model 3 police car instead of a fossil fuel vehicle. Among the department's conclusions: after four years the Tesla will have saved enough money to buy another Tesla, and each EV avoids emission of over 23 tons of CO_2 per year and saves $8763 in environmental and health costs. https://www.teslarati.com/tesla-model-3-westport-police-department-financial-analysis/ Those studies were based on much lower gas prices than exist today, which means that today's savings would be much larger.

[2]https://www.epa.gov/sites/production/files/2019-11/documents/co2ffc_2017.pdf
[3] DOE estimates that an EV in Virginia emits (via electric generation) less than a third as much CO2 as a gasoline-driven vehicle. https://afdc.energy.gov/vehicles/electric_emissions.html ; https://evtool.ucsusa.org/

[4] See June 23, 2020 Comments of the Sierra Club to the State Corporation Commission in SCC Docket PUR-2020-00051, Electrification of Motor Vehicles. As the comments explain, with managed off-peak charging and efficient rate structures, rising EV loads can drive down rates to all customers. Regarding operating costs, an EV has very little maintenance costs and EV's electricity cost equivalent to a gallon of gasoline, in Virginia, was $1.16 versus roughly $4.00/gallon today. https://www.energy.gov/maps/egallon

[5] https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/

[6] EV sales are already increasing, and every major vehicle manufacturer has committed to expand EV production and even to go all-electric over the next decade or so. Electric pick-up trucks will soon be available and there are long waiting lists for pick-ups. *See* https://www.reuters.com/business/autos-transportation/us-automakers-say-they-aspire-up-50-ev-sales-by-2030-sources-2021-08-04/ https://www.forbes.com/wheels/news/automaker-ev-plans/ ; https://www.cnbc.com/2022/01/05/chrysler-kicks-off-plans-to-go-all-electric-by-2028-with-airflow-concept.html ; https://www.electrive.com/2021/08/05/us-carmakers-aim-for-40-50-ev-sales-by-2030/
[7] https://www.forbes.com/wheels/news/jd-power-study-electric-vehicle-owners-prefer-dedicated-home-charging-stations/ See also James Walkinshaw, Washington Post, Jan. 23, p.C4 (explaining the importance of home charging relative to public charging). Utilities' energy sales are lowest and cheapest in off-peak hours, particularly at night. A common utility strategy is to offer time-of-use rates with low night-time prices to encourage off-peak EV charging. For EV customers to make use of such incentives, they will need access to overnight charging at home where they spend the night.

Resiliency Impact Statement: This proposal will increase Resiliency
Expanding EV utilization will enhance resiliency in multiple ways.

EVSE can be designed to deliver electricity back to a dwelling, which would protect residents during periods of power outages. https://www.ford.com/trucks/f150/f150-lightning/2022/ It is anticipated that EV batteries can also be connected to the grid to provide grid balancing and back up in the future.

Switching to EVs is also critical to resiliency because it will reduce CO2, CO, SO2, particulates, methane, and other harmful emissions from fossil-fuel combusting vehicles and from producing and delivering gasoline and diesel fuel for use in vehicles. Unlike traditional vehicles with internal combustion engines ("ICE"), electric vehicles emit no air pollution and are much more energy efficient than ICE vehicles. As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow.

According to Virginia's DEQ, "[t]he transportation sector is now the largest contributor of air pollutants and greenhouse gases in Virginia," and "[v]ehicle emissions are the largest single source of toxic and smog-forming air pollution in Northern Virginia and much of the rest of the country." https://www.deq.virginia.gov/air/clean-vehicles . Transportation accounts for 48.6% of Virginia's CO2 emissions. https://www.eia.gov/environment/emissions/state/

Polluting emissions from internal combustion vehicles compound the risks of climate change and adversely impact public health. CO2 and other emissions from fossil fuel combustion and production are the primary drivers of climate change. The most recent IPCC report confirms that rapid reductions of greenhouse gas emissions is essential to avoid catastrophic climate impacts around the world. IPCC Sixth Assessment Report (February 2022), https://www.ipcc.ch/report/ar6/wg2/ Substantial harm has already occurred nationally and locally from global warming and much worse will follow without rapid reductions of greenhouse gases (particularly CO2 and methane associated with fossil fuel production and combustion).

Virginia's coastal areas are among the most vulnerable to sea level rise and destructive storms. They already experience "sunny day flooding," and sea level rise is accelerating. https://www.vims.edu/newsandevents/topstories/2020/slrc_2019.php Climate change is already harming Virginia and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane associated with fossil fuel production and combustion). The most recent report from NOAA indicates that Virginia may face 2 feet of sea level rise by 2050 due to worsening climate change from human greenhouse gas emissions. https://www.noaa.gov/news-release/us-coastline-to-see-up-to-foot-of-sea-level-rise-by-2050 Virginia faces climate-driven sea level rise of 6.69 feet this century; the rate of sea level rise is accelerating; the danger of climate-driven severe storms, storm-surges and flooding are rising; and climate change will increasingly harm human health and lives, agriculture, businesses, military installations, private and public property, and Virginia's economy. http://www.vasem.org/reports/2021-the-impact-of-climate-change-on-virginias-coastal-areas/

Climate dangers, however, are not limited to coastal areas. https://www.wvtf.org/news/2022-04-28/study-shows-virginia-at-increased-risk-for-flash-floods-and-landslides Growing dangers also include rising atmospheric and water temperatures that worsen heat-related illnesses, disruptions of economic activity, and harms to agriculture, fisheries, and our natural heritage.

Because atmospheric CO2 from emissions is cumulative, Virginia has less chance of mitigating and recovering from those harms the longer we delay maximizing energy savings and minimizing greenhouse gas pollution.

Shifting to EVs is a critical piece of the solution to global warming. Continuing to construct buildings that will not support use of clean EVs will make it harder to achieve climate goals, particularly since the buildings will likely remain in place for 70 years or more. Constructing buildings that cannot provide electric charging will also delay residents' ability to access large economic and energy savings from EV usage.

Building codes already recognize that fumes from traditional vehicles are dangerous. More broadly, small particle, SO2 and other pollution from vehicles burning fossil fuels increases heart and lung disease, as well as cognitive and other disorders. https://blog.ucsusa.org/dave-reichmuth/air-pollution-from-cars-trucks-and-buses-in-the-u-s-everyone-is-exposed-but-the-burdens-are-not-equally-shared/ As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow particularly if we shift vehicles to clean electricity. Local air pollution harms caused by vehicle pollution will also be reduced which will particularly benefit high-traffic areas, including low-income urban areas.

Cost Impact: The code change proposal will increase the cost of construction

The code change proposal will slightly increase the cost of residential construction, but the increase will be very small compared to the total cost of construction and to the savings and other benefits to residents and the public. EVs with home charging will save occupants money and avoid the higher costs of retrofitting in the future.

It is easy to install the wires, panel capacity and conduits for electric vehicle charging--along with the rest of a dwelling's wiring--when a single or multifamily dwelling is built. It is much harder and much more expensive to do so as a retrofit. The branch circuit would cost a few dollars per foot. In a single-family dwelling garage or carport, for example, a branch circuit would need to be run from the circuit breaker, which is simple when other circuits and outlets are being installed during construction. However, as a retrofit, this basic wiring could require much higher costs from complicated feeding of a line and the potential need to open walls and repair wall damage.

The incremental cost of installing the branch circuit and related equipment during construction residence is constructed (likely 0.0005-0.003 or less of the cost of an average new home). If an electric panel is located in a garage, the added cost of EV readiness could easily be less than $100.

EC-C405.10-21

VECC: C202 (New), C405.10 (New), C405.10.1 (New), Table C405.10.1 (New), C405.10.2 (New)

Proponents: William Penniman (wpenniman@aol.com)

2018 Virginia Energy Conservation Code

Add new text as follows:

C202 General Definitions (Commercial). SECTION C202 GENERAL DEFINITIONS

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, electric motorcycles and the like, which is primarily powered by an electric motor that draws current from a rechargeable storage battery. A “plug-in hybrid” is a type of electric vehicle which relies on a combination of a rechargeable storage battery and another source of motive power.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the Electric Vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or charging apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.

EVSE INSTALLED SPACE. A designated parking space which is provided with EVSE, including an energized branch circuit with at least 40-ampere, 208/240 volts capacity that connects electric panel capacity to charging apparatus located within three feet of the parking space.

EV CAPABLE SPACE. A designated parking space which is provided with electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for EVSE, and with an adequately-sized raceway from the panel to a clearly identified location within three feet of the parking space, to support future EVSE.

EV READY SPACE. A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit and adequate electric panel capacity and space to electrify EVSE. The circuit shall terminate in a suitable termination point, such as a receptacle, junction box, or an EVSE, located within three feet of the parking space.

C405.10 Electric Vehicle (EV) charging for multifamily construction.. New multifamily construction shall provide and facilitate future installation and use of Electric Vehicle Supply Equipment (EVSE) in accordance with the National Electrical Code (NFPA 70) and C405.10.1.

Exception: EVSE Installed, EV Ready Spaces and EV Capable Spaces are not required where no parking spaces are provided to residents.

C405.10.1 Multifamily EV Readiness. Multifamily buildings not covered by R404.2 **(N1104.2)** shall provide EVSE Installed Spaces, EV Ready Spaces and EV Capable Spaces in proportion to the number of dwelling units in accordance with Table C405.10.1, such that the total number of such spaces equals the number of dwelling units for which parking spaces are made available to residents. Where the calculation of percentages of spaces to be served results in a fractional parking space, it shall round up to the next whole number. If a multifamily project is built in phases, the minimum number of EV Installed, EV Ready and EV Capable spaces shall be determined separately for each phase. Raceways to outdoor parking spaces shall be located underground and protected from water.

Table C405.10.1

Minimum EVSE Installed, EV Ready and EV Capable Spaces in Large Residential Buildings.

Type of space	**Minimum number of spaces installed at completion of construction or phase of construction**
EVSE Installed Spaces	Greater of 1 or 15% of total number of dwelling units
EV Ready Spaces	Greater of 1 or 15% of total number of dwelling units
EV Capable Spaces	Total number of dwelling units minus the sum of (EVSE Installed and EV Ready spaces)

C405.10.2 Identification. The service panel or subpanel circuit directory shall identify the spaces reserved to support EV charging as “EVSE Installed,” “EV Capable” or “EV Ready” and shall be updated as EVSE Installed Spaces are created. The raceway location shall be permanently and visibly marked as “EV Capable”. Construction documents shall indicate the raceway termination point and proposed location of future EV spaces and EV chargers. Construction documents shall also provide information on amperage of future EVSE, raceway methods, wiring schematics and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EVSE.

Reason Statement: This provision is designed to provide electric charging readiness for the growing use of electric vehicles (EVs) and to meet the essential need to offer at-home charging to residents of multifamily dwellings many of whom own EVs or would like to acquire EVs in the future. It is designed to minimize construction costs by phasing of EV charging development, with an emphasis on installing infrastructure during initial construction. To limit costs, the proposal is tied to the number of dwelling units for which parking is provided, not the total number of parking spaces. It also phases installation of chargers and branch circuits, with most of the emphasis being on the infrastructure of electric raceways and space for equipment needed to deliver the electricity. The rate at which the raceways are put to use will depend on the growth of demand.

In the case of multifamily construction, the proposal requires defined numbers of initial EV Installed, EV Ready spaces and EV Capable Spaces. The total of the three categories is tied to the number of dwelling units which are eligible for parking so that all residents have an opportunity to charge an EV when one is acquired. The intent is to provide a modest number of EV Installed and EV Ready Spaces from the outset, with EV Capable Spaces for the remainder up to the number of dwelling units for which parking is provided. Buildings that house individuals receiving medical or other care may not provide parking to serve residents of all dwelling units. The proposal will benefit residents and the public, saving money and cutting pollution.

EVs are growing in importance and will continue to grow in importance as climate risks compel shifting to vehicles that do not emit pollution and as more people recognize the potential value of owning or leasing EVs. EVs will save EV users up to $1900 per year in operating expenses compared to traditional vehicles (and more at today's high gas prices).[1] Those operating savings will further encourage EV sales growth and will greatly exceed the costs of pre-wiring garages and installing other necessary infrastructure during construction. Installing during construction is much cheaper than doing so by retrofit.

Vehicles are Virginia's largest source of carbon-dioxide emissions from fossil fuel combustion.[2] Even based on today's mix of generation in Virginia, DOE estimates that EVs would reduce CO2 emissions by roughly two-thirds compared to vehicles combusting gasoline.[3] Emissions from generation that supplies EVs will decline more as utilities' zero-carbon renewable energy replaces fossil-fuel generation. EVs' direct emissions are non-existent, which also has substantial health and pollution benefits compared to gasoline or diesel vehicles. Furthermore, in addition to the EV user's savings on annual operating costs (energy and maintenance), EV charging during off-peak periods can lead to a reduction of electric rates to all utility customers.[4]There is a national goal to have 50% of new vehicles to be EVs by 2030.[5] Major vehicle manufacturers have committed to shift production to EVs over the next 10 years with a number of manufactures committing to shift to 100% EV production in the next 5-10 years.[6].

At-home charging in conjunction with single and multifamily parking is important to meeting the needs of EV owners and to encourage charging during utilities' off-peak periods. According to research by JD Power, "80% of EV charging is done at home—almost always overnight—or while a car is parked during the workday" and EV users strongly prefer Level 2 (220/240V) charging. [7]

As a matter of equity, it is vital that residents of multifamily dwellings have access to the benefits of EVs, including the large reductions of operating costs and cleaner air. The absence of at-home EV charging is a major barrier for multifamily residents. The long periods required to fully charge an EV (7-10 hours with Level 2 charging depending on the size of the battery and level of charge) virtually requires at-home access to charging infrastructure. Off-peak charging can also save money on the electric rates. Going forward, utilities may get the added benefit of being able to draw on the batteries of parked electric vehicles in order meet peak demands and balance fluctuating loads. The public infrastructure for charging is still limited with relatively few "high speed" Level 3 chargers. Even when that public infrastructure is available, drivers have limited ability to take advantage of off-peak rates without home-charging.

Installing the wiring and basic infrastructure during construction when walls are open, parking is being constructed and workers are present is much cheaper than retrofitting. The presence of the wiring from the beginning (EV Ready) would permit low-cost installation of a different charging system to meet EV owners' needs. The presence of raceways from the beginning (EV Capable) will make it easy to expand service as demand grows. Failure to install the EV during infrastructure will create barriers to EV adoption and to the cost and pollution reductions that will come from EV utilization. Those barriers will be particularly great in the context of multifamily dwellings where retrofit costs are much higher and landlords' interests conflict with those of tenants.

[1] *See* Consumer Reports, "EVs Offer Big Savings Over Traditional Gas-Powered Cars" (October 2020); Union of Concerned Scientists, https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles (up to $1900/year savings for rural EV owners); https://augustafreepress.com/deq-launches-clean-air-communities-program-aimed-at-driving-investment-in-electric-vehicle The police department of Westport Connecticut achieved operating and maintenance savings of over $17,000 in its first year of using a Tesla Model 3 police car instead of a fossil fuel vehicle. Among the department's conclusions: after four years the Tesla will have saved enough money to buy another Tesla, and each EV avoids emission of over 23 tons of CO2 per year and saves $8763 in environmental and health costs. https://www.teslarati.com/tesla-model-3-westport-police-department-financial-analysis/

[2]https://www.epa.gov/sites/production/files/2019-11/documents/co2ffc_2017.pdf

[3] DOE estimates that an EV in Virginia emits (via electric generation) less than a third as much CO2 as a gasoline-driven vehicle. https://afdc.energy.gov/vehicles/electric_emissions.html ; https://evtool.ucsusa.org/

[4] See June 23, 2020 Comments of the Sierra Club to the State Corporation Commission in SCC Docket PUR-2020-00051, Electrification of Motor Vehicles. As the comments explain, with managed off-peak charging and efficient rate structures, rising EV loads can drive down rates to all customers. Regarding operating costs, an EV has very little maintenance costs and EV's electricity cost equivalent to a gallon of gasoline, in Virginia, was $1.16 versus roughly $4.00/gallon today. https://www.energy.gov/maps/egallon

[5] https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-american-leadership-forward-on-clean-cars-and-trucks/
[6] EV sales are already increasing, and every major vehicle manufacturer has committed to expand EV production and even to go all-electric over the next decade or so. Electric pick-up trucks will soon be available and there are long waiting lists for pick-ups. *See* https://www.reuters.com/business/autos-transportation/us-automakers-say-they-aspire-up-50-ev-sales-by-2030-sources-2021-08-04/ https://www.forbes.com/wheels/news/automaker-ev-plans/ ; https://www.cnbc.com/2022/01/05/chrysler-kicks-off-plans-to-go-all-electric-by-2028-with-airflow-concept.html https://www.electrive.com/2021/08/05/us-carmakers-aim-for-40-50-ev-sales-by-2030/
[7] https://www.forbes.com/wheels/news/jd-power-study-electric-vehicle-owners-prefer-dedicated-home-charging-stations/ See also James Walkinshaw, Washington Post, Jan. 23, p.C4 (explaining the importance of home charging relative to public charging). Utilities' energy sales are lowest and cheapest in off-peak hours, particularly at night. A common utility strategy is to offer time-of-use rates with low night-time prices to encourage off-peak EV charging. For EV customers to make use of such incentives, they will need access to overnight charging at home where they spend the night.

Resiliency Impact Statement: This proposal will increase Resiliency
Expanding EV utilization will enhance resiliency in multiple ways.

It is anticipated that EV batteries can be connected to the grid to provide grid balancing and back up in the future.

Switching to EVs is also critical to resiliency because it will reduce CO_2, CO, SO_2, particulates, methane, and other harmful emissions from fossil-fuel combusting vehicles and from producing and delivering gasoline and diesel fuel for use in vehicles. Unlike traditional vehicles with internal combustion engines ("ICE"), electric vehicles emit no air pollution and are much more energy efficient than ICE vehicles. As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow.

According to Virginia's DEQ, "[t]he transportation sector is now the largest contributor of air pollutants and greenhouse gases in Virginia," and "[v]ehicle emissions are the largest single source of toxic and smog-forming air pollution in Northern Virginia and much of the rest of the country." https://www.deq.virginia.gov/air/clean-vehicles . Transportation accounts for 48.6% of Virginia's CO_2 emissions. https://www.eia.gov/environment/emissions/state/

Polluting emissions from internal combustion vehicles compound the risks of climate change and adversely impact public health. CO_2 and other emissions from fossil fuel combustion and production are the primary drivers of climate change. The most recent IPCC report confirms that rapid reductions of greenhouse gas emissions is essential to avoid catastrophic climate impacts around the world. IPCC Sixth Assessment Report (February 2022), https://www.ipcc.ch/report/ar6/wg2/ Substantial harm has already occurred nationally and locally from global warming and much worse will follow without rapid reductions of greenhouse gases (particularly CO_2 and methane associated with fossil fuel production and combustion). Virginia's coastal areas are among the most vulnerable to sea level rise and destructive storms. They already experience "sunny day flooding," and sea level rise is accelerating. https://www.vims.edu/newsandevents/topstories/2020/slrc_2019.php Coastal areas are not the only part of Virginia threatened by worsening storms. https://www.wvtf.org/news/2022-04-28/study-shows-virginia-at-increased-risk-for-flash-floods-and-landslides

Climate change is already harming Virginia and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO_2 and methane associated with fossil fuel production and combustion). The most recent report from NOAA indicates that Virginia may face 2 feet of sea level rise by 2050 due to worsening climate change from human greenhouse gas emissions. https://www.noaa.gov/news-release/us-coastline-to-see-up-to-foot-of-sea-level-rise-by-2050 Virginia faces climate-driven sea level rise of 6.69 feet this century; the rate of sea level rise is accelerating; the danger of climate-driven severe storms, storm-surges and flooding are rising; and climate change will increasingly harm human health and lives, agriculture, businesses, military installations, private and public property, and Virginia's economy. http://www.vasem.org/reports/2021-the-impact-of-climate-change-on-virginias-coastal-areas/ Growing dangers also include rising atmospheric and water temperatures that worsen heat-related illnesses, disruptions of economic activity, and harms to agriculture, fisheries, and our natural heritage.

Because atmospheric CO_2 from emissions is cumulative, Virginia has less chance of mitigating and recovering from those harms the longer we delay maximizing energy savings and minimizing greenhouse gas pollution.

Shifting to EVs is a critical piece of the solution to global warming. Continuing to construct buildings that will not support use of clean EVs will make it harder to achieve climate goals, particularly since the buildings will likely remain in place for 70 years or more. Constructing buildings that cannot provide electric charging will also delay residents' ability to access large economic and energy savings from EV usage.

Building codes already recognize that fumes from traditional vehicles are dangerous. More broadly, small particle, SO_2 and other pollution from vehicles burning fossil fuels increases heart and lung disease, as well as cognitive and other disorders. https://blog.ucsusa.org/dave-reichmuth/air-pollution-from-cars-trucks-and-buses-in-the-u-s-everyone-is-exposed-but-the-burdens-are-not-equally-shared/ As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow particularly if we shift vehicles to clean electricity. Local air pollution harms caused by vehicle pollution will also be reduced which will particularly benefit high-traffic areas, including low-income urban areas.

Cost Impact: The code change proposal will increase the cost of construction

This code change proposal will somewhat increase the cost of constructing parking, but the increase will be small compared to the total cost of building construction and to the annual savings and other benefits to residents and the public. The availability of at-home charging charging will save residents money and avoid the higher costs of retrofitting in the future.The incremental cost of installing the electric equipment will be low when a residence is constructed. It is easy to install the wires, panel capacity and conduits for electric vehicle charging--along with the rest of a dwelling's wiring--when parking for multifamily dwelling or a nonresidential building is being constructed. It is much harder and much more expensive to do so as a retrofit. The branch circuit would cost a few dollars per foot, and raceways are also inexpensive.

The net benefits are clear. The costs per space of installing EV readiness during construction are less than the forecast savings of fuel and maintenance costs for residents with EVs. As DOE has explained: "Installing infrastructure during new construction avoids the retrofit costs of breaking and repairing walls, installing longer raceways, and using more expensive methods of upgrading service panels." See PNNL-31576, "Electric Vehicle Charging for Residential and Commercial Energy Codes: Technical Brief" (July 2021). While the potential costs can vary widely, they are reduced by addressing during initial construction, by taking advantage of upfront planning (e.g., as to locations of electrical systems and parking), and by economies of scale. The PNNL report (p.12) showed that 12 EV spaces in a 60-space parking structure would cost $860 per space with new construction or $2,370 per space with a retrofit, while 2 spaces in a 10 space lot would cost $930 per space with new construction or $3,710 per space in a retrofit. It states (p.7), "The availability and ease of access to Level 2 and DCFC EVSE is a critical barrier to EV adoption. A lack of pre-existing EV charging infrastructure, such as electrical panel capacity, raceways, and pre-wiring, can make the installation of a new charging station cost-prohibitive for a potential EV-owner. (fn omitted). Those costs would be a small fraction of new construction costs or rents, but a potential barrier to later installation.

In a large multifamily building, the cost would be greater than for a single-family dwelling due the larger garage or parking lot size and possibly the garage design. However, the costs of the infrastructure required by the proposal are still low compared to the overall construction cost, to potential retrofit costs, to residents' long-term savings from EVs, and to harm from impeding tenants' ability to reduce carbon and other pollutants which will reduce pollutants and benefit the public. The cost can be minimized by locating the EVSE (or future location for the EVSE) close to the electrical panels.

The proposal limits the costs both by limiting the requirements to one covered space per dwelling unit and to a limited number of spaces planned for employees and by deferring of much of the costs with respect to EV Ready and EV Capable spaces.

Staging, as spelled out in the Table, means that residents of every dwelling unit will have the opportunity to home-charge an EV, and the remaining electrical wiring and charger costs would only be incurred as occupant demand grows. (Sharing EV chargers would further slow the rate of build out; and, as demand evolves, lower capacity wire in the raceways might suffice for residents with plug-in hybrids.) The requirements for non-residential buildings are likely to be less than for multifamily. In submissions to the IECC as part of the 2021 IECC review process, data indicated that the cost of retrofitting commercial parking to EV ready status would be 3-8 times higher than doing to work at the time of building construction. See IECC Proposal CE217-19 Part 1(Cost Impact discussion). Such high retrofit costs will deter future retrofits and act as a barrier to EV access by residents of multifamily dwellings, potentially for decades.

EC-C405.11.1-21

VCC: C202 (New), C405.11.1 (New), TABLE C405.11.1 (New)

Proponents: William Penniman (wpenniman@aol.com)

2018 Virginia Construction Code

Add new text as follows:

C202 GENERAL DEFINITIONS. Add:
ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, electric motorcycles and the like, which is primarily powered by an electric motor that draws current from a rechargeable storage battery. A “plug-in hybrid” is a type of electric vehicle which relies on a combination of a rechargeable storage battery and another source of motive power.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the Electric Vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or charging apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.

EVSE INSTALLED SPACE. A designated parking space which is provided with EVSE, including an energized branch circuit with at least 40-ampere, 208/240 volts capacity that connects electric panel capacity to charging apparatus located within three feet of the parking space.

EV CAPABLE SPACE. A designated parking space which is provided with electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for EVSE, and with an adequately-sized raceway from the panel to a clearly identified location within three feet of the parking space, to support future EVSE.

EV READY SPACE. A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit and adequate electric panel capacity and space to electrify EVSE. The circuit shall terminate in a suitable termination point, such as a receptacle, junction box, or an EVSE, located within three feet of the parking space.

C405.11.1 EV Readiness for Certain Commercial Buildings Other Than Multifamily. Commercial construction other than multifamily that includes parking spaces for use by employees or students shall, at a minimum, provide EVSE Installed, EV Ready and EV Capable Parking Spaces shown in Table C405.11.1. Where the calculation of percentages of spaces to be served results in a fractional parking space, it shall round up to the next whole number. If a covered project is built in phases, the minimum number of required spaces shall be determined separately for each phase. Raceways to outdoor parking spaces shall be located underground and protected from water.
EXCEPTIONS: EVSE Installed, EV Ready and EV Capable Parking Spaces are not required for parking intended for vehicle inventory, vehicle storage, construction equipment, commercial customer use or farms.

TABLE C405.11.1
Number of EV Ready Spaces for Certain Non-Multifamily Construction.

Type of building/space	EVSE Installed	EV Ready	EV Capable
Office, manufacturing or processing plants with more than 10 parking spaces for employees	Greater of 1 or 5% of employee spaces	Greater of 1 or 10% of employee spaces	Greater of 1 or 20% of such spaces of employee spaces
Hotel, motel, extended stay, other temporary lodging	Greater of 1 or 5% of sleeping units if more than 10 such units	Greater of 1 or 10% of sleeping units if more than 10 such units	30% of sleeping units if more than 10 such units
Educational institutions if more than 10 spaces to be provided for faculty and other employees or students	Greater of 1 or 5% of spaces provided to faculty and other employees and 1 or 5% spaces provided to students	Greater of 1 or 10% of spaces provided to faculty and other employees and 1 or 5% of spaces provided to students	Greater of 1 or 20% of spaces provided to faculty and other employees and 1 or 10% of spaces provided to students

Reason Statement: This provision is designed to provide electric charging readiness for the growing use of electric vehicles (EVs) and to meet the need for some EV charging capabilities for certain workplaces, temporary lodgings, and educational venues. It recognizes that employees, travelers and students may travel considerable round-trip distances from home or may not have access to at-home charging. Substantially or fully charging an EV can take many hours, which fits with a typical workday or overnight at home, but not along the roadway as an addition to a typical commute. The proposal will benefit businesses and their employees and students. It will also benefit the public and enhance the economy by cutting air, water and climate pollution from internal combustion engines; by saving money for vehicle users; by saving time by charging vehicles when they are going to be parked anyway, and by reducing noise pollution. Reductions of air and climate pollution will have huge health, safety and infrastructure benefits.
The proposal is designed to minimize costs through phasing of EV development, with an emphasis on installing infrastructure during initial construction. Installing the wiring and basic infrastructure during construction is much cheaper than retrofitting. The proposal requires a relatively small upfront investment in infrastructure, with easy installation of additional chargers (EVSE) as needs grow. It assumes that there is a lesser need

for workplace and customer EV charging than at-home charging (assuming at-home charging develops), but recognizes that some EV charging capabilities are needed at workplaces and commercial venues. Not everyone will have access to at-home EV charging, and many employees will need some workplace charging to support expanded EV usage. Residents of older buildings and ones who rely on street parking are unlikely to get at-home charging for many years, if ever.

The proposal focuses on employees, travelers and students because of their unique needs and the likelihood that they will be able to use EV charging for a period of hours. Employees typically must work regular daily schedule; must commute farther to work than customers do for shopping; are likely to be at their workplace for extended periods; and have less time for roadside-charging. Travelers who drive will generally need overnight charging at places of lodging.

The intent is to provide a modest number of EV Installed and EV Ready Spaces from the outset, with EV Capable Spaces available for easy charging expansion as demand rises.

Providing access to at-work charging is also important as a matter of equity since residents of older, multifamily dwellings and townhouses are least likely to have access to at-home charging. Although the purchase cost of EVs is currently higher than the low end of vehicles with combustion engines, the purchase price is falling as competition grows and, more importantly, the EV savings in fuel and maintenance costs more than pay for the initial price difference. Also, air pollution from traditional vehicles is particularly harmful to low-income residents of Virginia.

EVs are growing in importance and will continue to grow in importance as climate risks compel shifting to vehicles that do not emit pollution and as more people recognize the potential value of owning or leasing EVs. EVs will save EV users up to $1900 per year in operating expenses compared to traditional vehicles (based on prices when those reviews were done, which were considerably lower than the $4.00/gallon or so seen today).[1] Those operating savings will encourage EV sales growth and will greatly exceed the costs of pre-wiring parking lots and installing other necessary infrastructure during construction. Installing during construction is much cheaper than doing so by retrofit.

Vehicles are Virginia's largest source of carbon-dioxide emissions from fossil fuel combustion.[2] Even based on today's mix of generation in Virginia, DOE estimates that EVs would reduce CO2 emissions by roughly two-thirds compared to vehicles combusting gasoline.[3] Emissions from generation that supplies EVs will decline more as utilities' zero-carbon renewable energy replaces fossil-fuel generation. EVs' direct emissions are non-existent, which also has substantial health and pollution benefits compared to gasoline or diesel vehicles.

Unfortunately, charging EVs is a time-consuming process. Even "Level 2" (40 amp, 208-240Volt) charging will only add 20-30 miles of range per hour of charging; while Level 1 provides approximately 5 miles per hour of charging. That creates a significant problem for individuals who cannot charge at work or home.

There is a national goal to have 50% of new vehicles to be EVs by 2030.[4] Major vehicle manufacturers have committed to shift production to EVs over the next 10 years with a number of manufactures committing to shift to 100% EV production in the next 5-10 years.[5]. According to research by JD Power, "80% of EV charging is done at home—almost always overnight—or while a car is parked during the workday" and EV users strongly prefer Level 2 (220/240V) charging. [6] The opportunity to charge at work is critical for long-distance commuter and for drivers who cannot install at-home charging due to their reliance on street parking or living in older buildings that lack parking or charging. The availability of at-work and at-home charging will substantially reduce barriers to EV adoption that arise from the inconveniences that EV charging is slower than pumping gasoline.. Going forward, utilities may get the added benefit of being able to draw on the batteries of parked electric vehicles in order meet peak demands and balance fluctuating loads..

[1] See Consumer Reports, "EVs Offer Big Savings Over Traditional Gas-Powered Cars" (October 2020); Union of Concerned Scientists, https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles (up to $1900/year savings for rural EV owners); https://augustafreepress.com/deq-launches-clean-air-communities-program-aimed-at-driving-investment-in-electric-vehicle The police department of Westport Connecticut achieved operating and maintenance savings of over $17,000 in its first year of using a Tesla Model 3 police car instead of a fossil fuel vehicle. Among the department's conclusions: after four years the Tesla will have saved enough money to buy another Tesla, and each EV avoids emission of over 23 tons of CO2 per year and saves $8763 in environmental and health costs. https://www.teslarati.com/tesla-model-3-westport-police-department-financial-analysis/ Those studies were based on much lower gas prices than exist today, which means that today's savings would be much larger. Regarding operating costs, an EV has very little maintenance costs and EV's electricity cost equivalent to a gallon of gasoline, in Virginia, was $1.16 versus roughly $4.00/gallon today. https://www.energy.gov/maps/egallon

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[4] https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/fact-sheet-president-biden-announces-steps-to-drive-americanleadership-forward-on-clean-cars-and-trucks/

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[6] https://www.forbes.com/wheels/news/jd-power-study-electric-vehicle-owners-prefer-dedicated-home-charging-stations/ See also James Walkinshaw, Washington Post, Jan. 23, p.C4 (explaining the importance of home charging relative to public charging). Utilities' energy sales are lowest and cheapest in off-peak hours, particularly at night. A common utility strategy is to offer time-of-use rates with low night-time prices to encourage off-peak EV charging. For EV customers to make use of such incentives, they will need access to overnight charging at home where they spend the night.

Resiliency Impact Statement: This proposal will increase Resiliency
Expanding EV utilization will enhance resiliency in multiple ways.
Many potential EV users lack at-home EV charging capabilities, which means that some workplace coverage is essential. Travelers also need access to overnight charging during stays at hotels and motels. Even if an employee or student has access to EV charging at home, the ability to charge at work can offset power outages at home. EVSE can be designed to deliver electricity back to a building or to the utility grid. https://www.ford.com/trucks/f150/f150-lightning/2022/
Switching to EVs is also critical to resiliency because it will reduce CO2, CO, SO2, particulates, methane, and other harmful emissions from fossil fuel combusting vehicles and from producing and delivering gasoline and diesel fuel for use in vehicles. Unlike traditional vehicles with internal combustion engines ("ICE"), electric vehicles emit no air pollution and are much more energy efficient than ICE vehicles. As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow.
According to Virginia's DEQ, "[t]he transportation sector is now the largest contributor of air pollutants and greenhouse gases in Virginia," and "[v]ehicle emissions are the largest single source of toxic and smog-forming air pollution in Northern Virginia and much of the rest of the country." https://www.deq.virginia.gov/air/clean-vehicles . Transportation accounts for 48.6% of Virginia's CO2 emissions. https://www.eia.gov/environment/emissions/state/
Polluting emissions from internal combustion vehicles compound the risks of climate change and adversely impact public health. CO2 and other emissions from fossil fuel combustion and production are the primary drivers of climate change. The most recent IPCC report confirms that rapid reductions of greenhouse gas emissions is essential to avoid catastrophic climate impacts around the world. IPCC Sixth Assessment Report (February 2022), https://www.ipcc.ch/report/ar6/wg2/ Substantial harm has already occurred nationally and locally from global warming and much worse will follow without rapid reductions of greenhouse gases (particularly CO2 and methane associated with fossil fuel production and combustion). Virginia's coastal areas are among the most vulnerable to sea level rise and destructive storms. They already experience "sunny day flooding," and sea level rise is accelerating. https://www.vims.edu/newsandevents/topstories/2020/slrc_2019.php Climate change is already harming Virginia and the harms will get much worse if we do not sharply reduce GHG emissions (particularly CO2 and methane associated with fossil fuel production and combustion). The most recent report from NOAA indicates that Virginia may face 2 feet of sea level rise by 2050 due to worsening climate change from human greenhouse gas emissions. https://www.noaa.gov/news-release/us-coastline-to-see-up-to-foot-of-sealevel-rise-by-2050 Virginia faces climate-driven sea level rise of 6.69 feet this century; the rate of sea level rise is accelerating; the danger of climate-driven severe storms, storm-surges and flooding are rising; and climate change will increasingly harm human health and lives, agriculture, businesses, military installations, private and public property, and Virginia's economy. http://www.vasem.org/reports/2021-the-impact-of-climatechange-on-virginias-coastal-areas/ Growing dangers also include rising atmospheric and water temperatures that worsen heat-related illnesses, disruptions of economic activity, and harms to agriculture, fisheries, and our natural heritage.
Because atmospheric CO2 from emissions is cumulative, Virginia has less chance of mitigating and recovering from those harms the longer we delay maximizing energy savings and minimizing greenhouse gas pollution. Shifting to EVs is a critical piece of the solution to global warming. Continuing to construct buildings that will not support use of clean EVs will make it harder to achieve climate goals, particularly since the buildings will likely remain in place for 70 years or more. Constructing buildings that cannot provide electric charging will also delay residents' ability to access large economic and energy savings from EV usage.
Building codes already recognize that fumes from traditional vehicles are dangerous. More broadly, small particle, SO2 and other pollution from vehicles burning fossil fuels increases heart and lung disease, as well as cognitive and other disorders. https://blog.ucsusa.org/dave-reichmuth/airpollution-from-cars-trucks-and-buses-in-the-u-s-everyone-is-exposed-but-the-burdens-are-not-equally-shared/ As Virginia's electric grid shifts to zero-carbon generation, the emission reduction benefits will grow particularly if we shift vehicles to clean electricity. Local air pollution harms caused by vehicle pollution will also be reduced which will particularly benefit high-traffic areas, including low-income urban areas.

Cost Impact: The code change proposal will increase the cost of construction
The code change proposal will somewhat increase the cost of constructing parking, but the increase will be small compared to the total cost of construction and the benefits to employees, travelers, students and the public. Installing EV charging or at least readiness for EV charging at the covered locations will save users money on fuel and avoid the much higher costs of retrofitting parking in the future.The incremental cost of installing the electric equipment is much lower during initial construction. See PNNL-31576, "Electric Vehicle Charging for Residential and Commercial Energy Codes: Technical Brief" (July 2021). While the potential costs can vary widely, they are substantially reduced by addressing during initial construction, by taking advantage of upfront planning (e.g., as to locations of electrical systems and parking), and by economies of scale. The PNNL report (p.12) showed that 12 EV spaces in a 60-space parking structure would cost $860 per space with new construction or $2,370 per space with a retrofit, while 2 spaces in a 10 space lot would cost $930 per space with new construction or $3,710 per space in a retrofit. It states (p.7), "The availability and ease of access to Level 2 and DCFC EVSE is a critical barrier to EV adoption. A lack of pre-existing EV charging infrastructure, such as electrical panel capacity, raceways, and pre-wiring, can make the installation of a new charging station cost-prohibitive for a potential EV-owner. (fn omitted). Those costs would be a small fraction of new construction costs or rents, but a potential barrier to later installation.

In submissions to the IECC as part of the 2021 IECC review process, data indicated that the cost of retrofitting commercial parking to EV ready status would be 3-8 times higher than doing to work at the time of building construction. Such high retrofit costs will deter future retrofits and act as a barrier to EV expansion in Virginia.
It is easy to install the wires, panel capacity and conduits for electric vehicle charging--along with the rest of a dwelling's wiring--when a single or multifamily dwelling is built. It is much harder and much more expensive to do so as a retrofit, which may require tearing up walls or parking surfaces. The branch circuit for an EVSE Installed or EVSE Ready space would cost a few dollars per foot, and would not be required during construction for a EV Capable Space.

The cost can be minimized by locating the EVSE or future location for the EVSE close to the electrical infrastructure. The proposal limits the costs both by limiting the total requirement to many fewer than the total parking spaces to be constructed and by allowing deferral of some costs for EV Ready and EV Capable spaces. Also, while 40-Amp circuits are required for the initial EVSE Installed and EV Ready Spaces and the capacity is needed to handle future branch circuits in EV Capable raceways, the door is left open to the possibility that, with experience and new technology, lower-capacity wiring might eventually be installed in at least some EV Capable spaces.

EC-C403.7.7-21

VECC: C403.7.7

Proponents: Richard Grace (rgrace@culpepercounty.gov), VPMIA

2018 Virginia Energy Conservation Code

Revise as follows:

C403.7.7 Shutoff dampers (Mandatory). Outdoor air intake and exhaust openings and stairway and shaft vents shall be provided with Class I motorized dampers. The dampers shall have an air leakage rate not greater than 4 cfm/ft^2 (20.3 L/s • m^2) of damper surface area at 1.0 inch water gauge (249 Pa) and shall be labeled by an approved agency when tested in accordance with AMCA 500D for such purpose.

> **Exception:** ~~Any~~ Where a grease duct serving a Type I hood is installed in accordance with IMC Section 506.3 ~~shall not be required to have a~~ motorized or gravity ~~damper.~~ dampers shall not be installed.

Outdoor air intake and exhaust dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with the *International Mechanical Code* or the dampers are opened to provide intentional economizer cooling.

Stairway and shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system or the interruption of power to the damper.

> **Exception:** Nonmotorized gravity dampers shall be an alternative to motorized dampers for exhaust and relief openings as follows:
>
> 1. In buildings less than three stories in height above grade plane.
> 2. In buildings of any height located in *Climate Zones* 1, 2 or 3.
> 3. Where the design exhaust capacity is not greater than 300 cfm (142 L/s).

Nonmotorized gravity dampers shall have an air leakage rate not greater than 20 cfm/ft^2 (101.6 L/s • m^2) where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft^2 (203.2 L/s • m^2) where less than 24 inches (610 mm) in either dimension. The rate of air leakage shall be determined at 1.0 inch water gauge (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an approved agency.

Reason Statement: The current language does not prohibit motorized or gravity dampers from being installed in a grease duct. The language is more of a recommendation than a prohibition. "Shall not be required" is equivalent to "shall not be prohibited." VMC 506.3.7 states "duct systems serving a Type I hood shall be constructed and installed so that grease cannot collect in any portion thereof." Following that logic, VMC 506.3.11 states "fire dampers and smoke dampers shall not be installed in grease ducts." The ICC Commentary for IMC Section 503.11 states "Fire and smoke dampers are not compatible with grease ducts, and the duct enclosure requirements clearly account for the lack of such dampers where the ducts penetrate walls, floors and ceilings. Fire and smoke dampers would be made useless by the severe environment within grease ducts (e.g., high temperatures, grease, cleaning chemicals and water)." Motorized dampers, gravity dampers, backdraft dampers, barometric dampers, and any other type of damper that serves a purpose in a duct system would also be made useless by the severe environment within a grease duct.

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency
I believe the original intent was to prohibit motorized and gravity dampers from being installed in a grease duct, therefore this is a clarification change rather than a technical change that has no effect on resiliency.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
I believe the original intent was to prohibit motorized and gravity dampers from being installed in a grease duct, there fore this is a clarification change rather than a technical change that would have an effect on cost.

EC-C405.13(3)-21

IECC®: SECTION 202 (New), C405.13 (New), UL Chapter 06 (New)

Proponents: Ben Rabe (ben@newbuildings.org); Kimberly Newcomer (kim@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

Revise as follows:

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle* .

Add new text as follows:

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space). An *automobile parking space* that is provided with a dedicated *EVSE* connection.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated *automobile parking space* that is provided with electrica l i nfrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an *EVSE* .

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An *automobile parking space* that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed *EVSE* .

C405.13 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with *electric vehicle* power transfer infrastructure i n compliance with Sections C405.13.1 through C405.13.6.C405.13.1 Quantity . The number of required *EV spaces* , *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this Section and Table C405.13.1 based on the total number of *automobile parking spaces* and shall be rounded up to the nearest whole number. For R- 2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.

2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

3. Installed *EVSE* spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV readyspaces* and *EV capable spaces* .

4. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet minimum requirements for *EV capablespaces* .**5.** Where the Where all (100%) parking serving R-2 occupancies are *EV ready spaces* , requirements for *EVSE spaces* for R-2 occupancies shall not apply.

5. Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply .

6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.13.1 shall be used

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

Table C405.13.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

OCCUPANCY	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
GROUP A	10%	0%	10%
GROUP B	15%	0%	30%
GROUP E	2%	0%	5%
GROUP F	2%	0%	5%
GROUP H	1%	0%	0%
GROUP I	2%	0%	5%
GROUP M	10%	0%	10%
GROUP R-1	20%	5%	75%
GROUP R-2	20%	5%	75%
GROUP R-3 AND R-4	2%	0%	5%
GROUP S exclusive of parking garages	1%	0%	0%
GROUP S-2 parking garages	1%	0%	0%

C405.13.2 EV Capable Spaces . Each *EV capable space* used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capablespace* and a suitable panelboard or other onsite electrical distribution equipment.

2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capacity in accordance with C405.13.5

3 The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.

4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future *electric vehicle supplyequipment* (EVSE)."

5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each *EV capable space* .

C405.13.3 EV Ready Spaces . Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.13.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each *EV ready space* it serves.

2. Have a minimum circuit capacity in accordance with C405.13.5.

3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.13.4 EVSE Spaces . An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces* . Each *EVSE* installed to meet the requirements of Section C405.13.1, serving either a single *EVSE space* or multiple *EVSE spaces* , shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.13.5.

2. Have a minimum charging rate in accordance with C405.13.4.1.

3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.

4. Be installed in accordance with Section C405.13.6.

C405.13.4.1 EVSE Minimum Charging Rate . Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).

2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charging each *EVSE space* at a minimum rate of no less than 3.3 kVA.

3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.13.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no l ess than 2.1 kVA.

C405.13.5 Circuit Capacity . The capacity of electrical infrastructure serving each *EV capable space* , *EV ready space* , and *EVSE space* shal l comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* it serves.

2. The requirements of C405.13.5.1.

C405.13.5.1 Circuit Capacity Management . The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.

2. Have a minimum capacity of 2.7 kVA per space when serving *EV ready spaces* or *EVSE spaces* for a building site when all (100%) of the automobile parking spaces are designed to be *EV ready* or *EVSE spaces* .

C405.13.6 EVSE Installation . *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

Revise as follows:

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

2202-2009 *Electric Vehicle (EV) Charging System- with revisions through February*

Add new text as follows:

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062

2594-2016 *Standard for Electric Vehicle Supply Equipment*

Reason Statement: Preparing our buildings for safe and convenient EV charging infrastructure is critical to deployment of electric vehicles. The transportation sector is the single largest source of GHG emissions in the nation. Near complete electrification of the transportation sector is necessary to achieve the GHG emission reductions needed to avoid the worst effects of climate change.
Electric vehicle sales increased by 80 percent from 2017 to 2018, and is expected to grow from 1 million vehicles at the end of 2018 to 18.7 million by 2030. As newer EVs with longer drive ranges enter the market, the older, shorter drive range EVs will move to the used vehicle market, and become readily accessible to a secondary market for which the accessibility of EV charging infrastructure at home and at work will be critical.

Inclusion in the IECC of EV Infrastructure requirements is critical in the prevention of the use of extension cords to inappropriate outlets for the purpose of vehicle charging. We must be building structures that will address the vehicles that the major automakers have already shown us they are producing, especially as they close out the production of ICE vehicles and switch to total EV manufacturing.

Buildings built in 2022 should last 50 years. By 2045 Ernst & Young predicts internal combustion engine (ICE) vehicles will make up less than 1% of new car sales globally. Bloomberg reports that the automakers' capital expenditures on capital equipment for electric vehicle manufacturing is important because it is the culmination of a manufacturer's multi-year exploration of the future; "Capex is Destiny." *

Shouldn't we be building structures to accommodate the vehicles that the automakers are telling us they are switching to? Shouldn't we be installing the infrastructure when it is least expensive to install? Shouldn't we be addressing the single largest source of GHG emissions?

Resiliency Impact Statement: This proposal will increase Resiliency
As electric vehicles (EVs) become more prevalent (as noted in reason statement) they will provide a valuable resource to the electric grid. EVs will essentially become mobile batteries available to the grid to help absorb load at renewable peak generation, or supply buildings to help smooth load peak demand or during emergency events. Beyond their contribution to the buildings they plug into and the grid they interact with, EVs will remove another direct combustion source from climate equation, helping prevent the worst impacts of climate change. Providing charging infrastructure to

new commercial and multifamily building will help speed the EV transition.

Cost Impact: The code change proposal will increase the cost of construction
Recent analysis by NBI and partners using cost data from RSMeans and the PNNL medium office prototype found that the average total cost of an EVSE space in a commercial parking lot was $4702: $1558 in materials and $3145 in labor. These costs include a dual-head commercial Clipper Creek EVSE mounted on a commercial pedestal, raceways, and all electrical conductors. If the electrical panel and onsite transformer have to be upsized – something that will only happen on some projects – there would be an additional cost of $1200 per space.

Using the same prototype and data sources, each EV capable space required an additional cost of $123 per space for conduit (assuming an average 100' run) and junction boxes if no capacity upgrade is required. If the panel and onsite transformer have to upsized to accommodate design loads, then that cost could increase by $1200 per space.

However, with the future demand for EVs and EV charging discussed in the reason statement, commercial parking facilities that do not include EV spaces during new construction will face substantially higher costs to retrofit those spaces in the future. For example, a cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric (PG&E) showed that the cost of an EV Ready space (full circuit for level 2 charging) installed during new construction was $860-$920, while a retrofit would cost $2370-$3710,[1] 3-4 times the cost. An analysis conducted by the California Air Resource Board found much higher cost savings of $7000 from avoided retrofit costs when EV spaces are installed during construction rather than retrofit, with the majority of the cost delta due to the cost of retrenching parking lots and doing costly panel and transformer upgrades.[2] The EV Capable spaces required by this proposal avoid nearly all of these incremental retrofit costs by including the most difficult elements to retrofit (trenching and panels) during new construction.

These EV chargers will also yield substantial economic benefits for both the individual that owns the EV and the building owner. For individuals, EVs cost much less to fuel and maintain than gas-powered vehicles. According to AAA, an electric vehicle (EV) will save roughly $1,039 per year in total fuel and maintenance costs compared to a comparable gasoline vehicle. Although Electric Vehicles are often more expensive than gasoline powered vehicles, Bloomberg New Energy Finance on battery costs suggests EVs could reach upfront cost parity with gasoline vehicles by the early-to-mid 2020s. For building owners, installing EV chargers will increase property values, attract new customers or tenants and improve staff and tenant retention.

With the growing market demand for EVs and the growing demand for charging they create, it not a question of if EV spaces will be needed, but when. Building owners and tenants will be paying for this cost now or in the future. Failing to install a minimal number of EVSE spaces and EV capable spaces now will saddle building owners and tenants with substantially higher costs due to costly future retrofits.

EC-C405.13(2)-21

IECC®: SECTION 202 (New), C405.13 (New), C405.13.1 (New), Table C405.13.1 (New), C405.13.2 (New), C405.13.2.1 (New), C405.13.3 (New), C405.13.3.1 (New), C405.13.4 (New), R404.4 (New), R404.4.1 (New), Table R404.4.1 (New), R404.4.2 (New), R404.4.2.1 (New), R404.4.3 (New), R404.4.3.1 (New), R404.4.4 (New)

Proponents: DHCD Staff (sbco@dhcd.virginia.gov)

2021 International Energy Conservation Code

Add new text as follows:

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space). An *automobile parking space* that is provided with a dedicated *EVSE* connection.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle* .

C405.13 Electric Vehicle Power Transfer Infrastructure. New parking facilities for R-2 occupancies with 50 units or more shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections C405.13.1 through C405.13.6.

C405.13.1 Quantity. The number of required *EV spaces* shall be determined in accordance with Table C405.13.1, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

Table C405.13.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE.

OCCUPANCY	EVSE SPACES
GROUP R-2	10%

C405.13.2 EVSE Spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section C405.13.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.13.3.
2. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
3. Be installed in accordance with Section C405.13.3.

C405.13.2.1 EVSE Minimum Charging Rate.

Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charing each *EVSE space* at a minimum rate of no less than 3.3 kVA.
3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.13.3.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

C405.13.3 Circuit Capacity. The capacity of electrical infrastructure serving each *EV space* shall have a branch circuit with a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EVSE space* it serves.

C405.13.3.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.

2. Have a minimum capacity of 2.7 kVA per space when serving *EVSE spaces* for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be *EVSE spaces*.
3. Have a minimum capacity of 2.7 kVA per space when serving *EVSE spaces* for a building site when all (100%) of the automobile parking spaces are designed to be *EVSE spaces*.

C405.13.4 EVSE Installation. *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

Revise as follows:

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

Add new text as follows:

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space). An *automobile parking space* that is provided with a dedicated *EVSE* connection.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle* .

R404.4 Electric Vehicle Power Transfer Infrastructure. New parking facilities for R-2 occupancies with 50 units or more shall be provided with *electric vehicle* power transfer infrastructure in compliance with Sections R404.4.1 through R404.4.4.

R404.4.1 Quantity. The number of required *EV spaces* shall be determined in accordance with Table R404.4.1, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

Table R404.4.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE.

OCCUPANCY	EVSE SPACES
GROUP R-2	10%

R404.4.2 EVSE Spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section R404.4.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with R404.4.3.
2. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section R404.4.4.

R404.4.2.1 EVSE Minimum Charging Rate. Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple *EVSE spaces* and controlled by an energy management system providing load management, be capable of simultaneously charing each *EVSE space* at a minimum rate of no less than 3.3 kVA.
3. When serving *EVSE spaces* allowed to have a minimum circuit capacity of 2.7 kVA in accordance with R404.4.3.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each *ESVE space* at a minimum rate of no less than 2.1 kVA.

R404.4.3 Circuit Capacity. The capacity of electrical infrastructure serving each *EV space* shall have a branch circuit with a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each *EVSE space* it serves.

R404.4.3.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving *EVSE spaces* for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be *EVSE spaces*.

3. Have a minimum capacity of 2.7 kVA per space when serving *EVSE spaces* for a building site when all (100%) of the automobile parking spaces are designed to be *EVSE spaces*.

R404.4.4 EVSE Installation. *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. *EVSE* shall be accessible in accordance with International Building Code Section 1107.

Reason Statement: This proposal was created by staff in response to a request from Delegates Reid and Bulova (letter attached) to "...make EV purchases a viable option for residents of multi-family dwelling units...". The proposal is partly based on CEPI-1-21, submitted for the 2024 IECC, but has been revised in several ways, including only addressing multi-family dwellings.

Resiliency Impact Statement: This proposal will increase Resiliency

Cost Impact: The code change proposal will increase the cost of construction
This proposal will increase the cost of construction.

Commonwealth of Virginia

General Assembly

RICHMOND

March 25th, 2021

Director Erik Johnston
Department of Housing and Community Development
Virginia Uniform Statewide Building Code
600 East Main Street #300
Richmond, VA, 23219

SUBJ: Virginia Uniform Statewide Building Code Updates - Electric Vehicle Charging Readiness

Dear Director Johnston:

As the Commonwealth continues the transition from fossil fuels to electric vehicles (EV), all aspects of the charging infrastructure need to be addressed. Several companies are making investments in roadside and destination charging; convenience stores and malls are using EV charging as a way to draw in customers for longer stays; and at-home, single-family charging installations are now more easily available for homeowners. However, for residents in either townhome communities, condominiums, or apartments, gaining access to EV charging is not readily available. The lack of charging infrastructure in these communities limits EV adoption and also limits the choices these individuals can make when purchasing a new or used vehicle.

In order to better accommodate the rising number of EV owners in Virginia and to make EV purchases a viable option for residents of multi-family dwelling units, we recommend and encourage DHCD to update the Virginia Uniform Statewide Building Code (USBC) to:

- Require that new multi-family dwelling units with 50 units or more set-aside at least 10% of their parking spaces for EV charging
- Make these spaces ready for EV charging during the design and construction process
- Provide electrical room/breaker box areas designed to accommodate the electrical equipment and distribution wiring to provide a minimum of a Level 2 chargers as defined by DoE (https://www.energy.gov/eere/electricvehicles/vehicle-charging) at each of the set-aside parking spaces

Apartment owners, condo associations, or homeowner associations may then negotiate with EV charging providers for installation, maintenance, and revenue sharing. We believe these measures will support the strategic goals outlined in the Virginia Energy Plan and Virginia Clean Economy Act; help to reduce carbon emissions in the transportation sector; facilitate EV purchases in Virginia; and allow residents of multi-family dwelling units to make purchase decisions on par with residents of single-family homes.
Sincerely,

David A. Reid
Delegate (VA-32)

David Bulova
Delegate (VA-37)

EC-C502.3-21

IECC®: C502.3, C502.7 (New), C503. (New), 506 (New)

Proponents: Ben Rabe (ben@newbuildings.org); Kimberly Newcomer (kim@newbuildings.org); Diana Burk (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

C502.3 Compliance. *Additions* shall comply with Sections C502.3.1 through ~~C502.3.6.2.~~ C502.7 .

Add new text as follows:

C502.7 Additional energy efficiency credits. *Additions* shall achieve a total of 10 credits in accordance with Section C506. *Alterations* to the existing building that are not part of an *addition* , but permitted with an *addition* , may be used to achieve the required credits.
Exceptions:

1. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H

2. *Additions* less than 1,000 ft^2 and less than 50% of existing floor area.

3. *Additions* that do not include the addition or replacement of equipment covered in Section C403.3 or C404.2 that achieve a total of 5 credits.

4. *Additions* that do not contain *conditioned space* that achieve a total of 5 credits.

5. *Buildings* in Residential Group R and Institutional Groups I in climate zones 3C, 4B, 4C, 5C that achieve a total of 5 credits

6. Where the *addition* alone or the existing building and *addition* together comply with Section C407

C503. Additional energy efficiency credits.. *Alterations* shall achieve a total of 5 credits in accordance with Section C506.
Exception:

1. *Alterations* that include replacement of no more than one of the following:

1.1. HVAC unitary systems or HVAC central heating or cooling equipment serving the *alteration* area.

1.2. 50% or more of the lighting fixtures in the *alteration* area.

1.3. 50% or more of the area of interior surfaces in the alteration area

1.4. 50% or more of the area of the *building's exterior wall envelope*

2. *Alterations* that are part of an *addition* complying with section C502.

3. *Alterations* that comply with Section C407.

506
ADDITIONAL EFFICIENCY CREDITS
. C506.1 General. Where required in Section C502 or C503, credits shall be achieved from Tables C406.1 (1) through C406.1 (5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables of calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.

2. Reduced lighting power in accordance with Section C406.3.

3. Enhanced lighting controls in accordance with Section C406.4.

4. On-site supply of renewable energy in accordance with Section C406.5.

5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.

6. High-efficiency service water heating in accordance with Section C406.7.

7. Enhanced envelope performance in accordance with Section C406.8.

8. Reduced air infiltration in accordance with Section C406.9

9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.

10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.

11. Efficient kitchen equipment in accordance with Section C406.12.

Reason Statement: Since 2012, the IECC has leveraged Section C406 to achieve additional efficiency in the prescriptive path. This section has received steady improvements over the subsequent code cycles with an expansion in the number of options and the adoption of a more flexible credit approach to the additional efficiency option. However, there is one significant gap in C406, it does not apply to additions or alterations. C502 and C503 do not reference C406 in the sections with which additions and alterations must comply. The exclusion from C406 is a significant loophole. Additions and large alterations are prime opportunities for achieving greater energy efficiency utilizing C406.
This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more proactive in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal creates a framework to apply C406 to additions and large alterations. It creates a new Section C506 that provides guidance for how to utilize C406 for existing buildings. C506.1 essentially replaces and mirrors C406.1, providing charging language for how to calculate credit totals and utilize the sections (C406.2-12) that establish the requirements for each credit option. This section C506 is utilized by new sections in C502 and C503 to set credit requirements for additions and alterations, respectively.

The new Section C502.2.7.1 sets requirements for additions. As additions generally have to meet the requirements for new construction, the credit requirement has been set at 10 credits, the same as C406 for new construction. The section specifically allows additions and alterations to comply together under this section, eliminating the possibility that a building with both an addition and alteration would have to achieve credits for each individually. The section includes a number of important exceptions for situations where achieving the full 10 credits would be less feasible due to lower energy building types, more limited credit options and more limited project scope:

1. Occupancies such as storage, utility, factory and high hazard that generally have low energy usage.

2. Small additions

3. Additions that do not include new HVAC or hot water systems that achieve 5 credits

4. Additions that do not include conditioned space that achieve 5 credits

5. Group R and I occupancies in more temperate climate zones that achieve 5 credits

6. Additions that comply with C407.

The new section C503.7 requires that large alterations achieve 5 credits. The section includes important exceptions:

1. The first exception ensures that the requirements only apply to large additions with significant scope. The exemption is worded to address small alterations that only impact one of the main buildings systems: envelope (C402), HVAC (C403), water heating (C404) and lighting (C405). Alterations that impact two or more of these systems – and must therefore comply with two or more of these sections – will have a larger scope with more opportunities to choose from among the available credit options.

2. An exception that reflects the allowance for alterations and additions to comply together under C502.

3. An exception for buildings that model using C407.

By limiting requirement to large alterations and keeping the credit requirement low, the proposal ensures that projects will likely have sufficient credit options within the existing scope of the project. The project team will be able to pick credit options that apply to building elements that are already within the project scope.

The savings for this proposal would be at least 2.5% for additions and 1.25% for alterations based on the modeling for the C406 credit options done by PNNL for the 2021 edition of the IECC. However, the savings should be higher for alterations in particular since the baselines for alterations include many below-code existing building features. Depending on how inefficient the rest of the building is, the impact of this proposal could be substantially higher without any greater cost than new construction C406 measures.

Resiliency Impact Statement: This proposal will increase Resiliency
Resiliency is an essential component of adapting to the effects of climate change. Encouraging energy efficient retrofits helps to reduce building energy use. This reduces the buildings overall reliance on energy, reducing carbon emissions directly and indirectly, lessening the impact on climate change and climate related events. For the building's own resilience, the proposed efficiency credits focus on more efficient systems overall – even in an event like a black out, these more efficient systems require less energy to run, making any back up generation energy source last longer – providing extended comfort and safety to building users. For energy infrastructure resilience, the electric grid's ability to deliver capacity to an increasing number of buildings will become increasingly important. By reducing overall energy use, this measure may contribute to a reduction in peak demand increasing the resiliency of the grid during high usage events.

Cost Impact: The code change proposal will increase the cost of construction
This proposal is crafted so that it will only impact major renovations / large-scope alterations that are already impacting the major systems that serve as the basis for credits under C406. This means that these projects are already undertaking the cost of bringing two or more of these major systems up to current code requirements, and the incremental cost is therefore only the cost from code rather than the cost of a standalone retrofit. Therefore, the costs for this proposal are the same as the costs for C406 requirements for new construction. However, savings for each package will generally be much higher since the rest of the building will nearly always have specifications that fall short of the latest energy code and each package will deliver greater savings. As a result, any package that is cost effective for new construction will be even more cost effective for major alterations.

EB805.2-21

VEBC: 805.2, 805.2.3 (New), 805.2.4 (New), 805.2.4.1 (New)

Proponents: Ben Rabe (ben@newbuildings.org)

2018 Virginia Existing Building Code

Revise as follows:

805.2 Residential compliance. Residential *additions* shall comply with ~~Section~~ the following:
1. Sections 805.2.1 or 805.2.2.

2. Sections 805.2.3 through R805.2.4.1.

Add new text as follows:

805.2.3 Heating and cooling systems. HVAC ducts newly installed as part of an addition shall comply with Section R403 of the VECC.

Exception: Where ducts from an existing heating and cooling system are extended to an addition , Sections R403.3.5 and R403.3.6 of the VECC

shall not be required..

805.2.4 Heating and cooling systems. New heating, cooling and duct systems newly installed as part of an alteration shall comply with Section R403 of the VECC. Alterations to heating, cooling and duct systems shall comply with this section.
Exception: Where ducts from an existing heating and cooling system are extended to an addition.

805.2.4.1 Duct Leakage. Where an alteration includes any of the following, ducts shall be tested in accordance with Section R403.3.5 of the VECC and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m2) of conditioned floor area:

1. Where 25% or more of the registers that are part of the duct system are relocated.

2. Where 25% or more of the total length of the ducts in the system are relocated.

3. Where the total length of all ducts in the system is increased by 25% or more.

Exception: Duct systems located entirely inside a conditioned space in accordance with R403.3.2.

Reason Statement: This proposal requires that existing ductwork serving new equipment in additions and alterations is tested. In an alteration, all ductwork serving new equipment will need to be tested. In additions, the ductwork serving the addition, both existing and new ductwork, will need to be tested if it increases the total volume of the ductwork serving the addition by more than 20%. The proposal does not include a performance criterion for the testing; the testing is informational.
The requirements for duct construction and sealing in the IECC have developed substantially over recent code cycles. Fiberboard materials, cloth tape, un-sealed duct joints, cavity plenum returns and other materials and approaches that can lead to very leaky ducts were once commonplace but are not now allowed by the IECC. The result is that the ductwork in many existing buildings fall far below modern standards.

Resiliency Impact Statement: This proposal will increase Resiliency
Resiliency is an essential component of adapting to the effects of climate change. Requiring duct testing for alterations increases efficiency and wasted energy though leaky ducts. As explained in reason statement, by delivering air where it was intended and not into wall cavities, homeowners benefit from proper temperature distribution in their homes, which should also decrease the amount of energy needed to overheat or overcool some parts of the home to get others to the right temperature. This also reduces the buildings overall reliance on energy, reducing carbon emissions directly and indirectly, lessening the impact on climate change and climate related events. By reducing overall energy use, this measure may contribute to a reduction in peak demand increasing the resiliency of the grid during high usage events.

Cost Impact: The code change proposal will increase the cost of construction
Duct tightening can be a very cost-effective energy retrofit. The replacement of equipment or substantial expansion of existing ductwork present prime opportunities to undertake this testing and will provide project teams and building owners important information about the relative need and savings opportunity that could come from duct tightening projects. It will also give project teams important information for configuring new equipment and ductwork to ensure the whole system performs effectively.

EB805.3-21

VEBC: 805.3, 805.3.3 (New), 805.3.4 (New), 805.3.5 (New)

Proponents: Ben Rabe (ben@newbuildings.org); Kimberly Newcomer (kim@newbuildings.org)

2018 Virginia Existing Building Code

Revise as follows:

805.3 Commercial compliance. Commercial *additions* shall comply with ~~Section~~ the following:
1. Sections 805.3.1 or 805.3.2.

Exception: Commercial *additions* complying with ANSI/ASHRAE/IESNA 90.1.

2. Sections 805.3.3. through 805.3.5.

Add new text as follows:

805.3.3 Mechanical systems acceptance testing. New mechanical systems that serve additions shall comply with Sections C408.2.2, C408.2.3 and C408.2.5 of the VECC.

Exceptions:

1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h

(140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.

2. Systems included in Section C403.5 of the VECC that serve individual dwelling units and sleeping units .

805.3.4 Service hot water systems acceptance testing. New service hot water systems that serve additions shall comply with Sections

C408.2.3 and C408.2.5 of the VECC.

Exceptions:

1. Service water heater systems in buildings where the total mechanical equipment capacity is less than 600,000 Btu/h (175.8 kW) combined

service water-heating and space-heating capacity.

2. Systems included in Section C403.5 of the VECC that serve individual dwelling units and sleeping units.

805.3.5 Lighting acceptance testing. New lighting systems that serve additions shall comply with Section C408.3 of the VECC.

Reason Statement: Due to the way that the charging language in the IECC is structured, new mechanical, water heating and lighting systems in additions do not need to meet the commissioning / acceptance testing requirements that the same systems in new construction would need to meet. This allows new systems in additions to go without this vital installation step and leaves them vulnerable to poor performance from installation. This proposal closes that loophole.
The proposal includes specific references to the appropriate commissioning /acceptance testing requirements in section C408:

- The balancing (C408.2.2), functional testing (C408.2.3) and documentation (C408.2.5) requirements for HVAC systems.
- The functional testing (C408.2.3) and documentation (C408.2.5) requirements for water heating systems
- The functional testing, documentation and reporting requirements for lighting (C408.3).

It repeats the system-size thresholds in the charging language in C408. The proposal also does not include references to the commissioning plan requirement (C408.2.1) for HVAC equipment. In this way, it has the same scope as the requirements for new construction. Since it references only new equipment in the addition itself, it avoids potentially requiring changes to the existing building systems.

Resiliency Impact Statement: This proposal will increase Resiliency
Resiliency is an essential component of adapting to the effects of climate change. Commissioning for existing building alterations helps building owners to understand the operations of their building systems and areas or operating sequences of concern. By understanding how systems will respond under a variety of operation conditions, building managers will be better equipped to adjust schedules or settings if needed in response to a climate, emergency, or resilience event. Systems that are commissioned additionally are operating at optimized conditions, meaning parts and

pieces of the system will not “short-cycle” or run longer or more frequently than intended in design. This will provide for overall longevity of the building systems as well – creating a different type of resilience and reliability for everyday operations and the building owner.

Cost Impact: The code change proposal will increase the cost of construction
The proposal will increase the cost of construction. However, these requirements have already been found to be sufficiently cost effective to be included in the code for new construction.

EB805.3(2)-21

VEBC: 805.3 (New), 805.3.3 (New), 805.3.4 (New), 805.3.5 (New)

Proponents: Ben Rabe (ben@newbuildings.org); Kimberly Newcomer (kim@newbuildings.org)

2018 Virginia Existing Building Code

Add new text as follows:

805.3 Commercial compliance. Commercial additions shall comply with the following:

1. Sections 805.3.1 or 805.3.2.

Exception: Commercial additions complying with ANSI/ASHRAE/IESNA 90.1.

2. Sections 805.3.3. through 805.3.5.

805.3.3 Mechanical system acceptance testing. Where an alteration requires compliance with Section C403 of the VECC or any of its subsections, mechanical systems that serve the alteration shall comply with Sections C408.2.2, C408.2.3 and C408.2.5 of the VECC.

Exceptions:

1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h

(140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.

1. Systems included in Section C403.5 VECC that serve individual dwelling units and sleeping units.

805.3.4 Service hot water system acceptance testing. Where an alteration requires compliance with Section C404 of the VECC or any of its subsections, service hot water systems that serve the alteration shall comply with Sections C408.2.3 and C408.2.5 of the VECC.

805.3.5 Lighting acceptance testing. Where an alteration requires compliance with Section C405 of the VECC or any of its subsections, lighting systems that serve the alteration shall comply with Section C408.3 of the VECC.

Reason Statement: The IECC requires that new mechanical, hot water and lighting systems comply with the acceptance testing requirements of C408. However, the IECC commentary for C503 states that unaltered portions of systems do not have to be brought into compliance with the code. This means that the requirements of C408 only apply to the new portions of existing systems. However, the whole purpose of C408 is to ensure that building systems meet and document a minimum level of system configuration. Even when only part of a system is replaced, there is still the need to ensure this minimum level of system configuration for the whole building. Even in like-for-like replacements, new equipment can have different operating characteristics. It is therefore important to ensure that the whole system is operating appropriately after new components are installed, not just the new components.
Additionally, all systems see their performance degrade over time as components wear, operational parameters change and modifications accumulate. The installation of new portions of equipment also presents the most reasonable and cost-effective opportunity to recalibration the system based on current operations. Therefore, this proposal requires that the whole system meet relevant C408 requirements, rather than just the new components. The proposal is tailored to focus on the parts of C408 that are relevant to existing buildings rather than just a blanket reference to C408 and includes specific references to the appropriate commissioning /acceptance testing requirements:

- The balancing (C408.2.2), functional testing (C408.2.3) and documentation (C408.2.5) requirements for HVAC systems.
- The functional testing (C408.2.3) and documentation (C408.2.5) requirements for water heating systems
- The functional testing, documentation and reporting requirements for lighting (C408.3).
- It repeats the system-size thresholds in the charging language in C408. In this way, it has the same scope as the requirements for new construction.

The proposal does not include references to the commissioning plan requirement (C408.2.1) for HVAC and SHW equipment (C408.2.4) since these requirements are most appropriate for new construction.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%.1,

Resiliency Impact Statement: This proposal will increase Resiliency
Resiliency is an essential component of adapting to the effects of climate change. Requiring energy efficiency through lighting controls in alterations helps to reduce overall building energy use. This reduces the buildings overall reliance on energy, reducing carbon emissions directly and indirectly, lessening the impact on climate change and climate related events. For the building's own resilience, the proposed efficiency credits focus on more efficient systems overall – even in an event like a black out, these more efficient systems require less energy to run, making any back up generation energy source last longer – providing extended comfort and safety to building users. For energy infrastructure resilience, the electric grid's ability to deliver capacity to an increasing number of buildings will become increasingly important. By reducing overall energy use, this measure may contribute to a reduction in peak demand increasing the resiliency of the grid during high usage events.

Cost Impact:
Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%. According to "Improving Commercial Building Operations through Building Re-tuning: Meta-Analysis," the median costs for building re-tuning was $0.16/sf.

EC-C1301.1.1-21

VCC: [E] 1301.1.1

Proponents: Matthew Benka (Matt@mdbstrategies.com); John Avis (avisj@avisconstruction.com)

2018 Virginia Construction Code

Revise as follows:

[E] 1301.1.1 Criteria. Buildings shall be designed and constructed in accordance with the *International Energy Conservation Code.*
Exception. Buildings with occupancy classifications of Factory Group F, Storage Group S or Utility and Miscellaneus Group U.

Reason Statement: The current energy code requirements are over burdensome for Factory Group F, Storage Group S, and Utility and Miscellaneous Group U. These use groups do not traditionally use a lot of energy as they are not heated or cooled to normal heating and cooling temperatures and or they create their own heat, etc. The change would eliminate unneeded and extra cost to the building owner. Additional insulation, roofing materials, and wall panel materials are being required in excess for buildings that will not fully utilized them.
Many storage facilities are vacant most of the time and a lot of manufacturing and utility buildings will have the drive through doors open during production.

The General Assembly of Virginia enacted the following legislation in 2022.

HB 1289 Uniform Statewide Building Code; exemption for certain use and occupancy classifications.

1. *§ 1. That the Board of Housing and Community Development is directed to consider, during the next code development cycle, revising the Uniform Statewide Building Code (§ 36-97 et seq. of the Code of Virginia) to provide an exemption from any requirements in the energy efficiency standards established pursuant to 13VAC5-63-264 of the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, and any subsequent amendments to the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) Section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U.*

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency
This code change does not have an effect on the resiliency of buildings in terms of withstanding disasters.

Cost Impact: The code change proposal will decrease the cost of construction
The recent update to the *International Energy Conservation Code* causes undue hardship on building owners, developers, and contractors while they do not reap the full benefits of the standards.

For example,

1. A 7,200 SF building, with limited heating to be used for vehicle storage. This current energy code and building code would require a standing seam roof system and (R19/R11) insulation in the roof and (R25) insulation in the walls. When priced with a fasten down roof system and just R19 in the roof and R13 walls, the material and labor price goes down by $5.97/SF. That equates to a cost of $42,984. That is enough to keep this project from being built.

2. A 100,000SF warehouse project used for storage of materials with heat maintained at 60 degrees or less and no cooling. The current building code and energy code would require a standing seam roof system and (R19/R11) insulation in the roof (R25) and insulation in the walls. Maintaining the standing seam roof system but changing the insulation to 6” in roof and 4” in walls results in a $311,247 deduct just for material. With labor, material, and equipment the cost savings approach $5.00/SF or $500,000.

The systems required to meet the current energy code are complicated and time consuming. These systems have other drawbacks such a liner system that cover up the purlins and girts affecting other trades such as plumbing, HVAC, electrical, and sprinkler. (The added cost to the electrical and mechanical trades are in addition to the cost shown in the examples above.) The trims on overhead doors and window on the new required systems are deep. These trims make the wall accessories look recessed and some would say less attractive. The current energy code makes some architectural features more difficult to design and build around. For example, just adding a masonry wainscot becomes a challenge.

Attached Files

- **HB1289.pdf**
  https://va.cdpaccess.com/proposal/997/1260/files/download/577/

VIRGINIA ACTS OF ASSEMBLY — CHAPTER

An Act to direct the Board of Housing and Community Development to consider, during the next code development cycle, certain revisions to the Uniform Statewide Building Code regarding energy efficiency requirements for certain use and occupancy classifications.

[H 1289]

Approved

Be it enacted by the General Assembly of Virginia:

1. *§ 1. That the Board of Housing and Community Development is directed to consider, during the next code development cycle, revising the Uniform Statewide Building Code (§ 36-97 et seq. of the Code of Virginia) to provide an exemption from any requirements in the energy efficiency standards established pursuant to 13VAC5-63-264 of the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, and any subsequent amendments to the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) Section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U.*

ENROLLED

HB1289ER

EC-C1301.1.1(2)-21

VCC: [E] 1301.1.1

Proponents: DHCD Staff (sbco@dhcd.virginia.gov)

2018 Virginia Construction Code

Revise as follows:

~~**[E]**~~ **1301.1.1 Criteria.** Buildings shall be designed and constructed in accordance with the *International Energy Conservation Code.*
Exception. Buildings with occupancy classifications of Factory Group F, Storage Group S or Utility and Miscellaneous Group U.

Reason Statement: This proposal is based on legislation (Full text provided below) directing the Board of Housing and Community Development to consider to provide an exemption from any requirements in the energy efficiency standards in the current USBC and subsequent amendments for use groups and occupancy classifications F, S and U. This proposal is a replica of EC-C1301.1.1 which is being considered for revisions by the proponent based on workgroup feedback.
In the event that proposal EC-C1301.1.1 is NOT amended, this proposal will be withdrawn.

CHAPTER 407
An Act to direct the Board of Housing and Community Development to consider, during the next code development cycle, certain revisions to the Uniform Statewide Building Code regarding energy efficiency requirements for certain use and occupancy classifications.

[H 1289]Approved April 11, 2022
Be it enacted by the General Assembly of Virginia:

1. *§ 1. That the Board of Housing and Community Development is directed to consider, during the next code development cycle, revising the Uniform Statewide Building Code (§ 36-97 et seq. of the Code of Virginia) to provide an exemption from any requirements in the energy efficiency standards established pursuant to 13VAC5-63-264 of the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, and any subsequent amendments to the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) Section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U.*

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency
This code change does not have an effect on the resiliency of buildings in terms of withstanding disasters (copied from EC-C1301.1.1).

Cost Impact: The code change proposal will decrease the cost of construction
This proposal will decrease the cost of construction.

EC-C401.2(2)-21

IECC®: C401.2

Proponents: Matthew Benka; John Avis (avisj@avisconstruction.com)

2021 International Energy Conservation Code

Revise as follows:

C401.2 Application. Commercial buildings shall comply with Section C401.2.1 or C401.2.2.

> Exception. In building areas where uses classified as Group F, S or U are located, the building envelope shall be permitted to comply with Appendix CB of this code.

Reason Statement: In consideration of discussion at the April 14 Energy General Workgroup Meeting, this proposal is offered as a potential alternative to EC-C1301.1.1-21 (ID 997).
The current energy code requirements are over burdensome for Factory Group F, Storage Group S, and Utility and Miscellaneous Group U. These use groups do not traditionally use a lot of energy as they are not heated or cooled to normal heating and cooling temperatures and or they create their own heat, etc. The change would eliminate unneeded and extra cost to the building owner. Additional insulation, roofing materials, and wall panel materials are being required in excess for buildings that will not fully utilize them. Many storage facilities are vacant most of the time and a lot of manufacturing and utility buildings will have the drive through doors open during production.

The General Assembly of Virginia enacted the following legislation in 2022.

HB 1289 Uniform Statewide Building Code; exemption for certain use and occupancy classifications.

1. § 1. That the Board of Housing and Community Development is directed to consider, during the next code development cycle, revising the Uniform Statewide Building Code (§ 36-97 et seq. of the Code of Virginia) to provide an exemption from any requirements in the energy efficiency standards established pursuant to 13VAC5-63-264 of the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, and any subsequent amendments to the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) Section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U.

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency
This code change does not have an effect on the resiliency of buildings in terms of withstanding disasters.

Cost Impact: The code change proposal will decrease the cost of construction
The recent update to the *International Energy Conservation Code* causes undue hardship on building owners, developers, and contractors while they do not reap the full benefits of the standards.

For example,

1. A 7,200 SF building, with limited heating to be used for vehicle storage. This current energy code and building code would require a standing seam roof system and (R19/R11) insulation in the roof and (R25) insulation in the walls. When priced with a fasten down roof system and just R19 in the roof and R13 walls, the material and labor price goes down by $5.97/SF. That equates to a cost of $42,984. That is enough to keep this project from being built.

2. A 100,000SF warehouse project used for storage of materials with heat maintained at 60 degrees or less and no cooling. The current building code and energy code would require a standing seam roof system and (R19/R11) insulation in the roof (R25) and insulation in the walls. Maintaining the standing seam roof system but changing the insulation to 6” in roof and 4” in walls results in a $311,247 deduct just for material. With labor, material, and equipment the cost savings approach $5.00/SF or $500,000.

The systems required to meet the current energy code are complicated and time consuming. These systems have other drawbacks such a liner system that cover up the purlins and girts affecting other trades such as plumbing, HVAC, electrical, and sprinkler. (The added cost to the electrical and mechanical trades are in addition to the cost shown in the examples above.) The trims on overhead doors and window on the new required systems are deep. These trims make the wall accessories look recessed and some would say less attractive. The current energy code makes some architectural features more difficult to design and build around. For example, just adding a masonry wainscot becomes a challenge.

Attached Files

- **APPENDIX CB (underlined).pdf**
  https://va.cdpaccess.com/proposal/1163/1649/files/download/688/

APPENDIX CB
BUILDING ENVELOPE REQUIREMENTS
GROUP F, S AND U BUILDING AREAS

SECTION CB101
SCOPE

CB101.1 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.

SECTION CB102
BUILDING ENVELOPE REQUIREMENTS

CB102.1 General.

CB102.1.1 Insulation and fenestration criteria.
The *building thermal envelope* shall meet the requirements of Tables CB102.2(1) and CB102.3 based on the climate zone specified in Chapter 3[CE]. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CB102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.

CB102.2 Specific insulation requirements.
Opaque assemblies shall comply with Table CB102.2(1).

CB102.2.1 Roof assembly.

The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CB102.2(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 CB102.2(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.

CB102.2.2 Classification of walls.

Walls associated with the building envelope shall be classified in accordance with Section CB102.2.2.1 or CB102.2.2.2.

CB102.2.2.1 Above-grade walls.

Above-grade walls are those walls covered by Section CB102.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

CB102.2.2.2 Below-grade walls.

Below-grade walls covered by Section CB102.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

CB102.2.3 Above-grade walls.

The minimum thermal resis-tance (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 CB102.2(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 CB102.2(1). "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m^2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 $kg\backslash m^3$).

CB102.2.4 Below-grade walls.

The minimum thermal resis-tance (R-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table CB102.2(1) and shall extend to a depth of 10 feet I (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CB102.2.5 Floors over outdoor air or unconditioned space.

The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing or con-tinuously on the floor assembly shall be as specified in Table CB102.2(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/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1,900 kg/m^3).

CB102.2.6 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 CB102.2(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.

CB102.2.7 Opaque doors.

Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table CB102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

TABLE CB102.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Roofs								
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-25 ci	R-25 ci
Metal buildings (with R-5 thermal blocks[a])[b]	R-19 + R-10	R-19	R-19	R-19	R-19	R-19	R-19 + R-10	R-19 + R-10
Attic and other	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38
Walls, Above Grade								
Mass	NR	NR	R-5.7 ci[c, e]	R-5.7 ci[c]	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal building[b]	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R - ß + R-7.5 ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-7.5 ci
Walls, Below Grade								
Below grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-7.5 ci
Floors								
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10 ci	R-15 ci	R-15 ci
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-on-Grade Floors								
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 24 in. below	R-10 for 36 in. below	R-10 for 36 in. below	R-10 for 48 in. below
Opaque Doors								
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.

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 descriptions can be found in Table CB102.2(2).

c. R-5.7 ci may be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 in. or less on center vertically and 48 in. or less on center horizontally, with ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu-in./h-f^2 F.

d. When heated slabs are placed below grade, below grade walls must meet 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 CB102.2(2)
METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTION	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. This construction is R-10 insulation batts draped perpendicularly over the purlins, with enough looseness to allow R-19 batt to be laid above it, parallel to the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins. In the metal building industry, this is known as the "sag and bag" insulation system.	ASHRAE/IESNA 90.1 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 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 Table A3.2
R-13 + R-13	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. The second layer of R-13 insulation batts is installed within the framing cavity.	ASHRAE/IESNA 90.1 Table A3.2

For SI: 1 inch = 25.4 mm.

CB102.3 Fenestration.

Fenestration shall comply with Table CB102.3.

CB102.3.1 Maximum area.

The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CB102.3. The skylight area shall not exceed the percentage of the gross roof area specified in Table CB102.3.

CB102.3.2 Maximum U-factor and SHGC.

For vertical fen-estration, the maximum U-factor and solar heat gain coeffi-cient (SHGC) shall be as specified in Table CB102.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CB102.3.

The window projection factor shall be determined in accordance with Equation CB-1.

$PF = A/B$ **(Equation CB-1)**

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or per-manently attached shading device to the vertical sur-face of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or per-manently 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.

CB102.4 Air leakage.

CB102.4.1 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 I 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.

> **Exception:** Site-constructed windows and doors that arc weatherstripped or sealed in accordance with Section CB102.4.3.

CB102.4.2 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 E 283. For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft^2) (5.5 m^3/h x m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft^2 (18.3 m^3/h x m^2) of door area when tested in accordance with ASTM E 283.

CB102.4.3 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.

CB102.4.4 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 m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance 1.0 inch with AMCA 500D.

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

TABLE CB102.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Vertical Fenestration (40% maximum of above-grade wall)								
***U*-Factor**								
Framing materials other than metal with or without metal reinforcement or cladding								
U-Factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain Wall/Storefront *U*-Factor	1.20	0.70	0.60	0.50	0.45	0.45	0.45	0.45
Entrance Door *U*-Factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All Other *U*-Factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.50	0.50
SHGC-All Frame Types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	NR	NR
SHGC: $0.25 \leq$ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
Glass								
U-Factor	1.60	1.05	0.90	0.60	0.60	0.60	0.60	0.60
SHGC	0.40	0.40	0.40	0.40	0.40	0.40	NR	NR
Plastic								
U-Factor	1.90	1.90	1.30	1.30	1.30	0.90	0.90	0.60
SHGC	0.35	0.35	0.35	0.62	0.62	0.62	NR	NR

NR = No requirement.
PF = Projection factor (See Section CB102.3.2)
a. All others includes operable windows, fixed windows and non-entrance doors.

CB102.4.5 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.

CB102.4.6 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 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CB102.4. 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 pre-formed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose, while maintaining required 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 E 283 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.

CB102.5 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 · m^2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E 96. 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.

APPENDIX CB
BUILDING ENVELOPE REQUIREMENTS
GROUP F, S AND U BUILDING AREAS

SECTION CB101
SCOPE

CB101.1 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.

SECTION CB102
BUILDING ENVELOPE REQUIREMENTS

CB102.1 General.

CB102.1.1 Insulation and fenestration criteria.
The *building thermal envelope* shall meet the requirements of Tables CB102.2(1) and CB102.3 based on the climate zone specified in Chapter 3[CE]. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CB102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.

CB102.2 Specific insulation requirements.
Opaque assemblies shall comply with Table CB102.2(1).

CB102.2.1 Roof assembly.

The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CB102.2(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 CB102.2(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.

CB102.2.2 Classification of walls.

Walls associated with the building envelope shall be classified in accordance with Section CB102.2.2.1 or CB102.2.2.2.

CB102.2.2.1 Above-grade walls.

Above-grade walls are those walls covered by Section CB102.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

CB102.2.2.2 Below-grade walls.

Below-grade walls covered by Section CB102.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

CB102.2.3 Above-grade walls.

The minimum thermal resis-tance (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 CB102.2(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 CB102.2(1). "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m^2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg\m^3).

CB102.2.4 Below-grade walls.

The minimum thermal resis-tance (R-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table CB102.2(1) and shall extend to a depth of 10 feet I (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CB102.2.5 Floors over outdoor air or unconditioned space.

The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing or con-tinuously on the floor assembly shall be as specified in Table CB102.2(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/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1,900 kg/m^3).

CB102.2.6 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 CB102.2(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.

CB102.2.7 Opaque doors.

Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table CB102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

TABLE CB102.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine4	6	7	8
Roofs								
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-25 ci	R-25 ci
Metal buildings (with R-5 thermal blocks[a])[b]	R-19 + R-10	R-19	R-19	R-19	R-19	R-19	R-19 + R-10	R-19 + R-10
Attic and other	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38
Walls, Above Grade								
Mass	NR	NR	R-5.7 ci[c, e]	R-5.7 ci[c]	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal building[b]	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R -ß + R-7.5 ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-7.5 ci
Walls, Below Grade								
Below grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-7.5 ci
Floors								
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10 ci	R-15 ci	R-15 ci
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-on-Grade Floors								
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 24 in. below	R-10 for 36 in. below	R-10 for 36 in. below	R-10 for 48 in. below
Opaque Doors								
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.

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 descriptions can be found in Table CB102.2(2).

c. R-5.7 ci may be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 in. or less on center vertically and 48 in. or less on center horizontally, with ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu-in./h-f[2] F.

d. When heated slabs are placed below grade, below grade walls must meet 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 CB102.2(2)
METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTION	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. This construction is R-10 insulation batts draped perpendicularly over the purlins, with enough looseness to allow R-19 batt to be laid above it, parallel to the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins. In the metal building industry, this is known as the "sag and bag" insulation system.	ASHRAE/IESNA 90.1 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 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 Table A3.2
R-13 + R-13	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. The second layer of R-13 insulation batts is installed within the framing cavity.	ASHRAE/IESNA 90.1 Table A3.2

For SI: 1 inch = 25.4 mm.

CB102.3 Fenestration.

Fenestration shall comply with Table CB102.3.

CB102.3.1 Maximum area.

The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CB102.3. The skylight area shall not exceed the percentage of the gross roof area specified in Table CB102.3.

CB102.3.2 Maximum U-factor and SHGC.

For vertical fen-estration, the maximum U-factor and solar heat gain coeffi-cient (SHGC) shall be as specified in Table CB102.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CB102.3.

The window projection factor shall be determined in accordance with Equation CB-1.

PF = A/B **(Equation CB-1)**

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or per-manently attached shading device to the vertical sur-face of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or per-manently 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.

CB102.4 Air leakage.

CB102.4.1 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 I 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.

> **Exception:** Site-constructed windows and doors that arc weatherstripped or sealed in accordance with Section CB102.4.3.

CB102.4.2 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 E 283. For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft^2) (5.5 m^3/h x m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft^2 (18.3 m^3/h x m^2) of door area when tested in accordance with ASTM E 283.

CB102.4.3 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.

CB102.4.4 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 m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance 1.0 inch with AMCA 500D.

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

TABLE CB102.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Vertical Fenestration (40% maximum of above-grade wall)								
***U*-Factor**								
Framing materials other than metal with or without metal reinforcement or cladding								
U-Factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain Wall/Storefront *U*-Factor	1.20	0.70	0.60	0.50	0.45	0.45	0.45	0.45
Entrance Door *U*-Factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All Other *U*-Factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.50	0.50
SHGC-All Frame Types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	NR	NR
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
Glass								
U-Factor	1.60	1.05	0.90	0.60	0.60	0.60	0.60	0.60
SHGC	0.40	0.40	0.40	0.40	0.40	0.40	NR	NR
Plastic								
U-Factor	1.90	1.90	1.30	1.30	1.30	0.90	0.90	0.60
SHGC	0.35	0.35	0.35	0.62	0.62	0.62	NR	NR

NR = No requirement.
PF = Projection factor (See Section CB102.3.2)
a. All others includes operable windows, fixed windows and non-entrance doors.

CB102.4.5 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.

CB102.4.6 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 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CB102.4. 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 pre-formed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose, while maintaining required 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 E 283 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.

CB102.5 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 · m^2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E 96. 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.

EC-Appendix CB-21

IECC®: C402.1.6 (New), APPENDIX CB (New), CB101 (New), CB101.1 (New), CB102 (New), CB102.1 (New), CB102.2 (New), CB102.2.1 (New), CB102.2.2 (New), CB102.2.2.1 (New), CB102.2.2.2 (New), CB102.2.2.3 (New), CB102.2.4 (New), CB102.2.5 (New), CB102.2.6 (New), CB102.2.7 (New), TABLE C402.1.3, TABLE CB102.2(2) (New), CB102.3 (New), CB102.3.1 (New), CB102.3.2 (New), CB102.4 (New), CB102.4.1 (New), CB102.4.2 (New), CB102.4.3 (New), CB102.4.4 (New), CB102.4.5 (New), CB102.4.6 (New), TABLE C402.4, CB102.4. 7 (New), CB102.5 (New)

Proponents: Matthew Benka; John Avis (avisj@avisconstruction.com)

2021 International Energy Conservation Code

Add new text as follows:

C402.1.6 Groups F, S, and U. Appendix CB may be used as an alternative to the *building thermal envelope* provisions of this code for Groups F, S, and U.

APPENDIX CB
BUILDING ENVELOPE REQUIREMENTS

CB101
Scope

CB101.1 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.

CB102
Building Envelope Requirements

CB102.1 Insulation and fenestration criteria. The building thermal envelope shall meet the requirements of Tables CB102.2(1) and CB102.3 based on the climate zone specified in Chapter 3[CE]. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CB102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.

CB102.2 Specific insulation requirements. Opaque assemblies shall comply with Table CB102.2(1).

CB102.2.1 Roof assembly. The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CB102.2(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 CB102.2(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.

CB102.2.2 Classification of walls. Walls associated with the building envelope shall be classified in accordance with Section CB102.2.2.1 or CB102.2.2.2.

CB102.2.2.1 Above-grade walls. Above-grade walls are those walls covered by Section CB102.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

CB102.2.2.2 Below-grade walls. Below-grade walls covered by Section CB102.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

CB102.2.2.3 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 CB102.2(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 CB102.2(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).

CB102.2.4 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 CB102.2(1) and shall extend to a depth of 10 feet I (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CB102.2.5 Floors over outdoor air or unconditioned space. The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing or continuously on the floor assembly shall be as specified in Table CB102.2(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 (1,900 kg/m3).

CB102.2.6 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 CB102.2(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.

CB102.2.7 Opaque doors. Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table CB102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

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-13
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
Joist/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/m^2, 1 pound per cubic foot = 16 kg/m^3.

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 purli

b. Assembly description can be found in Table CB102.2(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 ce

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for perimeter insulation according

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

Add new text as follows:

TABLE CB102.2(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 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 Table A2.3
Walls		
R-13	Single insulation layer The first layer of R-13 insulation batts is installed constinuously perpendicular to the girts and is compressed as the metal skin is attached to the girts.	ASHRAE/IESNA 90.1 Table A3.2
R-13 + R-13	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 Table A3.2

For SI: 1inch = 25.4 mm.

CB102.3 Fenestration. Fenestration shall comply with Table CB102.3.

CB102.3.1 Maximum area. The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CB102.3. The skylight area shall not exceed the percentage of the gross roof area specified in Table CB102.3.

CB102.3.2 Maximum U-factor and SHGC. For vertical fenestration, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CB102.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CB102.3.

The window projection factor shall be determined in accordance with Equation CB-1.

PF = A/B (Equation CB-1)

where:

PF = Projection factor (decimal).

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.

CB102.4
Air leakage

CB102.4.1 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 I 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.

Exception: Site-constructed windows and doors that arc weatherstripped or sealed in accordance with Section CB102.4.3.

CB102.4.2 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 E 283. 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 x 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 x m2) of door area when tested in accordance with ASTM E 283.

CB102.4.3 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.

CB102.4.4 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 1.0 inch with AMCA 500D.

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

CB102.4.5 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.

CB102.4.6 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.

Revise as follows:

TABLE CB102.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE			3	4 EXCEPT MARINE	5 AND MARINE 4			
Vertical fenestration (40% maximum of above-grade wall)								
***U*-factor**								
Framing materials othe rthan metal with or without metal reinforcement or cladding								
U-factor			0.65	0.40	0.35			
Metal framing with or without thermal break								
Curtain Wall/Storefront U-factor			0.60	0.50	0.45			
Entrance Door U-factor			.90	.85	.80			
All Other U-factor[a]			.65	.55	.55			
SHGC-All Fram 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								
U-Factor			0.90	0.60	0.60			
SHGC			0.40	0.40	0.40			
Plastic								
U-Factor			1.30	1.30	1.30			
SHGC			0.35	0.62	0.62			

NR = No Requirement, PF = Projection Factor (See Section CB102.3.2.

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

Add new text as follows:

CB102.4. 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 air-tight assembly manufactured for this purpose, while maintaining required 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 E 283 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.

CB102.5 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 x 10-11 kg/Pa· s · m2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E 96. 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.

Reason Statement: In consideration of discussion at the April 14 Energy General Workgroup Meeting, this proposal is offered as a potential alternative to EC-C1301.1.1-21 (ID 997). The proposed appendix is a companion to EC-C401.2-21 (ID 1163) and represents the building envelope requirements of the 2006 IECC.

The current energy code requirements are over burdensome for Factory Group F, Storage Group S, and Utility and Miscellaneous Group U. These use groups do not traditionally use a lot of energy as they are not heated or cooled to normal heating and cooling temperatures and or they create their own heat, etc. The change would eliminate unneeded and extra cost to the building owner. Additional insulation, roofing materials, and wall panel materials are being required in excess for buildings that will not fully utilize them.

Many storage facilities are vacant most of the time and a lot of manufacturing and utility buildings will have the drive through doors open during production.

The General Assembly of Virginia enacted the following legislation in 2022.

HB 1289 Uniform Statewide Building Code; exemption for certain use and occupancy classifications.

1. § 1. That the Board of Housing and Community Development is directed to consider, during the next code development cycle, revising the Uniform Statewide Building Code (§ 36-97 et seq. of the Code of Virginia) to provide an exemption from any requirements in the energy efficiency standards established pursuant to 13VAC5-63-264 of the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, and any subsequent amendments to the Virginia Uniform Statewide Building Code and the 2018 Virginia Energy Conservation Code, for the following use and occupancy classifications pursuant to Chapter 3 of the 2018 Virginia Construction Code: (i) Section 306, Factory Group F; (ii) Section 311, Storage Group S; and (iii) Section 312, Utility and Miscellaneous Group U.

Resiliency Impact Statement: This proposal will neither increase nor decrease Resiliency
This code change does not have an effect on the resiliency of buildings in terms of withstanding disasters.

Cost Impact: The code change proposal will decrease the cost of construction
The recent update to the *International Energy Conservation Code* causes undue hardship on building owners, developers, and contractors while they do not reap the full benefits of the standards.

For example,

1. A 7,200 SF building, with limited heating to be used for vehicle storage. This current energy code and building code would require a standing seam roof system and (R19/R11) insulation in the roof and (R25) insulation in the walls. When priced with a fasten down roof system and just R19 in the roof and R13 walls, the material and labor price goes down by $5.97/SF. That equates to a cost of $42,984. That is enough to keep this project from being built.

2. A 100,000SF warehouse project used for storage of materials with heat maintained at 60 degrees or less and no cooling. The current building code and energy code would require a standing seam roof system and (R19/R11) insulation in the roof (R25) and insulation in the walls. Maintaining the standing seam roof system but changing the insulation to 6” in roof and 4” in walls results in a $311,247 deduct just for material. With labor, material, and equipment the cost savings approach $5.00/SF or $500,000.

The systems required to meet the current energy code are complicated and time consuming. These systems have other drawbacks such a liner system that cover up the purlins and girts affecting other trades such as plumbing, HVAC, electrical, and sprinkler. (The added cost to the electrical and mechanical trades are in addition to the cost shown in the examples above.) The trims on overhead doors and window on the new required systems are deep. These trims make the wall accessories look recessed and some would say less attractive. The current energy code makes some architectural features more difficult to design and build around. For example, just adding a masonry wainscot becomes a challenge.

Attached Files

- **APPENDIX CB (underlined).pdf**
  https://va.cdpaccess.com/proposal/1196/1650/files/download/689/

APPENDIX CB
BUILDING ENVELOPE REQUIREMENTS
GROUP F, S AND U BUILDING AREAS

SECTION CB101
SCOPE

CB101.1 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.

SECTION CB102
BUILDING ENVELOPE REQUIREMENTS

CB102.1 General.

CB102.1.1 Insulation and fenestration criteria.
The *building thermal envelope* shall meet the requirements of Tables CB102.2(1) and CB102.3 based on the climate zone specified in Chapter 3[CE]. Buildings with a vertical fenestration area or skylight area that exceeds that allowed in Table CB102.3 shall comply with the building envelope provisions of ASHRAE/IESNA 90.1.

CB102.2 Specific insulation requirements.
Opaque assemblies shall comply with Table CB102.2(1).

CB102.2.1 Roof assembly.

The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table CB102.2(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 CB102.2(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.

CB102.2.2 Classification of walls.

Walls associated with the building envelope shall be classified in accordance with Section CB102.2.2.1 or CB102.2.2.2.

CB102.2.2.1 Above-grade walls.

Above-grade walls are those walls covered by Section CB102.2.3 on the exterior of the building and completely above grade or walls that are more than 15 percent above grade.

CB102.2.2.2 Below-grade walls.

Below-grade walls covered by Section CB102.2.4 are basement or first-story walls associated with the exterior of the building that are at least 85 percent below grade.

CB102.2.3 Above-grade walls.

The minimum thermal resis-tance (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 CB102.2(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 CB102.2(1). "Mass walls" shall include walls weighing at least (1) 35 pounds per square foot (170 kg/m^2) of wall surface area or (2) 25 pounds per square foot (120 kg/m^2) of wall surface area if the material weight is not more than 120 pounds per cubic foot (1,900 kg\m^3).

CB102.2.4 Below-grade walls.

The minimum thermal resis-tance (R-value) of the insulating material installed in, or continuously on, the below-grade walls shall be as specified in Table CB102.2(1) and shall extend to a depth of 10 feet I (3048 mm) below the outside finish ground level, or to the level of the floor, whichever is less.

CB102.2.5 Floors over outdoor air or unconditioned space.

The minimum thermal resistance (R-value) of the insulating material installed either between the floor framing or con-tinuously on the floor assembly shall be as specified in Table CB102.2(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/m^2) of floor surface area or (2) 25 pounds per square foot (120 kg/m^2) of floor surface area if the material weight is not more than 12 pounds per cubic foot (1,900 kg/m^3).

CB102.2.6 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 CB102.2(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.

CB102.2.7 Opaque doors.

Opaque doors (doors having less than 50 percent glass area) shall meet the applicable requirements for doors as specified in Table CB102.2(1) and be considered as part of the gross area of above-grade walls that are part of the building envelope.

TABLE CB102.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Roofs								
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20 ci	R-25 ci	R-25 ci
Metal buildings (with R-5 thermal blocks[a])[b]	R-19 + R-10	R-19	R-19	R-19	R-19	R-19	R-19 + R-10	R-19 + R-10
Attic and other	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38
Walls, Above Grade								
Mass	NR	NR	R-5.7 ci[c, e]	R-5.7 ci[c]	R-7.6 ci	R-9.5 ci	R-11.4 ci	R-13.3 ci
Metal building[b]	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13	R-13 + R-13
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R -ß + R-7.5 ci
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-13	R-13	R-13 + R-7.5 ci
Walls, Below Grade								
Below grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-7.5 ci
Floors								
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10 ci	R-15 ci	R-15 ci
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-30	R-30	R-30
Slab-on-Grade Floors								
Unheated slabs	NR	NR	NR	NR	NR	NR	NR	R-10 for 24 in. below
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 24 in. below	R-10 for 36 in. below	R-10 for 36 in. below	R-10 for 48 in. below
Opaque Doors								
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.50
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 0.50	U – 0.50	U – 0.50

For SI: 1 inch = 25.4 mm.

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 descriptions can be found in Table CB102.2(2).

c. R-5.7 ci may be substituted with concrete block walls complying with ASTM C 90, ungrouted or partially grouted at 32 in. or less on center vertically and 48 in. or less on center horizontally, with ungrouted cores filled with material having a maximum thermal conductivity of 0.44 Btu-in./h-f^2 F.

d. When heated slabs are placed below grade, below grade walls must meet 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 CB102.2(2)
METAL BUILDING ASSEMBLY DESCRIPTIONS

ROOFS	DESCRIPTION	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. This construction is R-10 insulation batts draped perpendicularly over the purlins, with enough looseness to allow R-19 batt to be laid above it, parallel to the purlins. Thermal blocks are then placed above the purlin/batt, and the roof deck is secured to the purlins. In the metal building industry, this is known as the “sag and bag” insulation system.	ASHRAE/IESNA 90.1 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 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 Table A3.2
R-13 + R-13	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. The second layer of R-13 insulation batts is installed within the framing cavity.	ASHRAE/IESNA 90.1 Table A3.2

For SI: 1 inch = 25.4 mm.

CB102.3 Fenestration.

Fenestration shall comply with Table CB102.3.

CB102.3.1 Maximum area.

The vertical fenestration area (not including opaque doors) shall not exceed the percentage of the gross wall area specified in Table CB102.3. The skylight area shall not exceed the percentage of the gross roof area specified in Table CB102.3.

CB102.3.2 Maximum U-factor and SHGC.

For vertical fen-estration, the maximum U-factor and solar heat gain coeffi-cient (SHGC) shall be as specified in Table CB102.3, based on the window projection factor. For skylights, the maximum U-factor and solar heat gain coefficient (SHGC) shall be as specified in Table CB102.3.

The window projection factor shall be determined in accordance with Equation CB-1.

$PF = A/B$ **(Equation CB-1)**

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or per-manently attached shading device to the vertical sur-face of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave, or per-manently 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.

CB102.4 Air leakage.

CB102.4.1 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 I 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.

> **Exception:** Site-constructed windows and doors that arc weatherstripped or sealed in accordance with Section CB102.4.3.

CB102.4.2 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 E 283. For curtain walls and storefront glazing, the maximum air leakage rate shall be 0.3 cubic foot per minute per square foot (cfm/ft^2) (5.5 m^3/h x m^2) of fenestration area. For commercial glazed swinging entrance doors and revolving doors, the maximum air leakage shall be 1.00 cfm/ft^2 (18.3 m^3/h x m^2) of door area when tested in accordance with ASTM E 283.

CB102.4.3 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.

CB102.4.4 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 m^2) at 1.0 inch water gauge (w.g.) (1250 Pa) when tested in accordance 1.0 inch with AMCA 500D.

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

TABLE CB102.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6	7	8
Vertical Fenestration (40% maximum of above-grade wall)								
***U*-Factor**								
Framing materials other than metal with or without metal reinforcement or cladding								
U-Factor	1.20	0.75	0.65	0.40	0.35	0.35	0.35	0.35
Metal framing with or without thermal break								
Curtain Wall/Storefront *U*-Factor	1.20	0.70	0.60	0.50	0.45	0.45	0.45	0.45
Entrance Door *U*-Factor	1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80
All Other *U*-Factor[a]	1.20	0.75	0.65	0.55	0.55	0.55	0.50	0.50
SHGC-All Frame Types								
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40	0.40	NR	NR
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR	NR	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR	NR	NR	NR
Skylights (3% maximum)								
Glass								
U-Factor	1.60	1.05	0.90	0.60	0.60	0.60	0.60	0.60
SHGC	0.40	0.40	0.40	0.40	0.40	0.40	NR	NR
Plastic								
U-Factor	1.90	1.90	1.30	1.30	1.30	0.90	0.90	0.60
SHGC	0.35	0.35	0.35	0.62	0.62	0.62	NR	NR

NR = No requirement.
PF = Projection factor (See Section CB102.3.2)
a. All others includes operable windows, fixed windows and non-entrance doors.

CB102.4.5 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.

CB102.4.6 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 m^2) in area.

5. Revolving doors.

6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

CB102.4. 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 pre-formed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose, while maintaining required 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 E 283 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.

CB102.5 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 · m^2) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E 96. 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.

RB113.1-21

VRC: 113.3

Proponents: KC Bleile (kc.bleile@viridiant.org)

2018 Virgina Residential Code

Revise as follows:

113.3 Minimum inspections. The following minimum inspections shall be conducted by the building official when applicable to the construction or permit:

1. Inspection of footing excavations and reinforcement material for concrete footings prior to the placement of concrete.
2. Inspection of foundation systems during phases of construction necessary to assure compliance with this code.
3. Inspection of preparatory work prior to the placement of concrete.
4. Inspection of structural members and fasteners prior to concealment.
5. Inspection of electrical, mechanical and plumbing materials, equipment and systems prior to concealment.
6. Inspection of energy provisions and conservation material prior to concealment.
7. Final inspection.

Reason Statement: The intent of this proposal is to clarify existing 2018 Virginia Residential Code Minimum Inspections found in Chapter 1 to aid in Building Code Official enforcement.

Resiliency Impact Statement: This proposal will increase Resiliency
This proposal will strengthen home resilience as it clarifies the minimum inspections related to energy code provisions.

Cost Impact:
None to builder as related to Building Code Official enforcement of existing code.