AGENDA
STAKEHOLDER SUBWORKGROUP MEETING
Energy Subworkgroup
Tuesday, March 31, 2020
9:30 a.m.

Adobe Connect:
https://vadhcd.adobeconnect.com/rhlwylc374pi/

Note: The Board of Housing and Community Development will not vote or take action on any item until a regular meeting of the Board. The workgroup will be open to public participation.

Energy Subworkgroup

March 31, 2020 9:30 AM

(Revised 3/26/20)

Adobe Connect:

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Agenda

I. **Welcome/Introductions**
II. **Review of proposal E402.4.2-18**
III. **Review of proposal E404.5-18**
IV. **Review of proposal E1301.1.1.1-18**
V. **Review of proposal EB402.1.4.2-18**
VI. **Review of proposal EB601.4(1)-18**
VII. **Review of proposal EB601.4(2)-18**
VIII. **Review of proposal EB601.4(2)-18**
IX. **Review of proposal EB601.4(3)-18**
X. **Review of proposal RE402.1.2(1)-18**
XI. **Review of proposal RE402.1.2(2)-18**
XII. **Review of proposal RE402.1.2(3)-18**
XIII. **Review of proposal RE402.1.2(4)-18**
XIV. **Review of proposal RE402.1.2(5)-18**
XV. **Review of proposal RE402.4.1.3-18**
XVI. **Review of proposal RE503.1.1.1-18**
XVII. **Other**
XVIII. **Adjournment**

E402.4.2-18

VECC: C402.4.2, C402.4.2.1, C402.4.2.2

Proponents: Haywood Kines (hkines@pwcgov.org)

2015 Virginia Energy Conservation Code

~~**C402.4.1.2**~~ **C402.4.2** ~~**Increased skylight**~~ **Skylight area with daylight responsive controls.** The skylight area shall be permitted to be not more than 5 percent of the roof area provided *daylight responsive controls* complying with Section C405.2.3.1 are installed in *daylight zones* under skylights.

Delete without substitution:

~~**C402.4.2 Minimum skylight fenestration area.** In an enclosed space greater than 2,500 square feet (232 m^2) in floor area, directly under a roof with not less than 75 percent of the ceiling area with a ceiling height greater than 15 feet (4572 mm), and used as an office, lobby, atrium, concourse, corridor, storage space, gymnasium/exercise center, convention center, automotive service area, space where manufacturing occurs, nonrefrigerated warehouse, retail store, distribution/sorting area, transportation depot or workshop, the total *daylight zone* under skylights shall be not less than half the floor area and shall provide one of the following:~~

~~1.A minimum skylight area to *daylight zone* under skylights of not less than 3 percent where all skylights have a VT of at least 0.40 as determined in accordance with Section C303.1.3.~~
~~2.A minimum skylight effective aperture of at least 1 percent, determined in accordance with Equation 4-4.~~

~~Skylight Effective Aperture = 0.85 Skylight Area Skylight VT WF Daylight zone under skylight~~

$$\text{Skylight Effective Aperture} = \frac{0.85 \cdot \text{Skylight Area} \cdot \text{Skylight VT} \cdot \text{WF}}{\text{Daylight zone under skylight}}$$ ~~**(Equation 4-4)**~~

~~where:~~

~~Skylight area = Total fenestration area of skylights.~~

~~Skylight VT = Area weighted average visible transmittance of skylights.~~

~~WF = Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 feet (610 mm), or 0.7 if light well depth is 2 feet (610 mm) or greater.~~

~~Light well depth = Measure vertically from the underside of the lowest point of the skylight glazing to the ceiling plane under the skylight.~~

~~**Exception:** Skylights above *daylight zones* of enclosed spaces are not required in:~~

~~1.Buildings in *Climate Zones* 6 through 8.~~
~~2.Spaces where the designed *general lighting* power densities are less than 0.5 W/ft^2 (5.4 W/m^2).~~
~~3.Areas where it is documented that existing structures or natural objects block direct beam sunlight on at least half of the roof over the enclosed area for more than 1,500 daytime hours per year between 8 a.m. and 4 p.m.~~
~~4.Spaces where the *daylight zone* under rooftop monitors is greater than 50 percent of the enclosed space floor area.~~
~~5.Spaces where the total area minus the area of *daylight zones* adjacent to vertical fenestration is less than 2,500 square feet (232 m^2), and where the lighting is controlled according to Section C405.2.3.~~

C402.4.2.1 ~~**Lighting controls in daylight zones**~~ **Daylight Zone Controls under skylights.** *Daylight responsive controls* complying with Section C405.2.3.1 shall be provided to control all electric lights within *daylight zones* under skylights.

C402.4.2.2 Haze factor. Skylights that are installed in office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store and distribution/sorting area spaces shall have a glazing material or diffuser with a haze factor greater than 90 percent when tested in accordance with ASTM D1003.

Exception: Skylights designed and installed to exclude direct sunlight entering the occupied space by the use of fixed or automated baffles or the geometry of skylight and light well.

Reason Statement: The Section C402.4.2 has mandatory requirements for skylights in all buildings that will have an area greater than 2500 sq. ft with a ceiling height of 15 ft. this Code section lists building uses that by design is technically infeasible to install skylights to meet the minimum area requirements. Typically these roof areas are used for HVAC equipment, and PV systems as well as possible structural issues based on actual design of the buildings.

Bibliography: This proposal will increase Resiliency
This proposal will help industry for compliance with the VECC, the number of possible skylights that could be required may not be practicable or

improve energy efficiency

Cost Impact: The code change proposal will decrease the cost of construction
This change will element the additional cost of skylights in buildings that are already providing Daylight Zones with the windows and doors. This lighting is required to have separate Daylight Zone controls from the general lighting controls as well as meeting the requirements for the allowable lighting Budget and comply with additional efficiency requirements in Section C406 Additional Efficiency Package Options.

E404.5-18

IECC®: C404.5, C404.5.1, TABLE C404.5.1, C404.5.2, C404.5.2.1

Proponents: Kenney Payne, AIA Virginia (kpayne@moseleyarchitects.com)

2018 International Energy Conservation Code

Delete without substitution:

~~**C404.5 Heated water supply piping.** Heated water supply piping shall be in accordance with Section C404.5.1 or C404.5.2. The flow rate through $^{1}/_{4}$ inch (6.4 mm) piping shall be not greater than 0.5 gpm (1.9 L/m). The flow rate through $^{5}/_{16}$ inch (7.9 mm) piping shall be not greater than 1 gpm (3.8 L/m). The flow rate through $^{3}/_{8}$ inch (9.5 mm) piping shall be not greater than 1.5 gpm (5.7 L/m).~~

~~**C404.5.1 Maximum allowable pipe length method.** The maximum allowable piping length from the nearest source of heated water to the termination of the fixture supply pipe shall be in accordance with the following. Where the piping contains more than one size of pipe, the largest size of pipe within the piping shall be used for determining the maximum allowable length of the piping in Table C404.5.1.~~

~~1.For a public lavatory faucet, use the "Public lavatory faucets" column in Table C404.5.1.~~
~~2.For all other plumbing fixtures and plumbing appliances, use the "Other fixtures and appliances" column in Table C404.5.1.~~

TABLE C404.5.1
PIPING VOLUME AND MAXIMUM PIPING LENGTHS

NOMINAL PIPE SIZE (inches)	VOLUME (liquid ounces per foot length)	MAXIMUM PIPING LENGTH (feet)	
		Public lavatory faucets	Other fixtures and appliances
1/4	0.33	6	50
5/16	0.5	4	50
3/8	0.75	3	50
1/2	1.5	2	43
5/8	2	1	32
3/4	3	0.5	21
7/8	4	0.5	16
1	5	0.5	13
1 1/4	8	0.5	8
1 1/2	11	0.5	6
2 or larger	18	0.5	4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 liquid ounce = 0.030 L, 1 gallon = 128 ounces.

C404.5.2 Maximum allowable pipe volume method. The water volume in the piping shall be calculated in accordance with Section C404.5.2.1. Water heaters, circulating water systems and heat trace temperature maintenance systems shall be considered to be sources of heated water.

The volume from the nearest source of heated water to the termination of the fixture supply pipe shall be as follows:

1. For a public lavatory faucet: not more than 2 ounces (0.06 L).
2. For other plumbing fixtures or plumbing appliances; not more than 0.5 gallon (1.89 L).

C404.5.2.1 Water volume determination. The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the nearest source of heated water and the termination of the fixture supply pipe. The volume in the piping shall be determined from the "Volume" column in Table C404.5.1. The volume contained within fixture shutoff valves, within flexible water supply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

Reason Statement: The problem of heated water taking an excessively long time to arrive at lavatory faucets in public restrooms is well known. The length of time the faucets are used during each hand washing event is very short, often around 5 seconds. Federal law requires low flow rate or small, metered volumes for the faucets in these applications. Health codes expect heated water for washing hands in these applications. The dilemma is that the volume of not-hot water in the piping from the source of hot water to the faucets is much too large for the heated water to arrive in a timely fashion; even at the 50-foot limit currently required in the 2012 IPC. Supporting this proposal will correlate the IECC with Federal law and local health codes by providing heated water for hand washing in a timely manner. The delivery of hot water to public lavatory faucets needs to be considered separately because of potential health issues. The events are short and the flow rates are low. Table 1 shows the time-to-tap performance based on the requirements in the proposal. The 0.25 and 0.5 gpm columns are typical of the flow rates for public lavatory faucets. The volume in the pipe was chosen so that heated water would arrive in the first part of the hot water event so that every person who uses the public lavatory will have the benefits of hot water.

The energy savings comes from not losing the heat from the water as it tries to arrive at the faucets. For more information and background on issues related to hot water distribution please read the 4-part series at:
http://www.allianceforwaterefficiency.org/Residential_Hot_Water_Distribution_System_Introduction.aspx

Providing heated water "in the first part of the hot water event" is a noble goal, but it conflicts with the IPC and increases cost (initial and operating).

Generally the energy code should not be governing plumbing code topics like this, the plumbing code is where this should live and govern maximum distances from heating sources to fixtures that require hot water.

To recap, in order to meet section C404.5 of the Virginia energy code this would require very unusual hot water piping design strategies (looped/ serpentine mains) and lots of recirculation taps and/or lots of instantaneous/ tankless water heating strategies. This would certainly cost a lot more money to install with little or no energy benefit in most applications (most likely uses more energy).

This proposal would get hot water to fixtures much faster, should be in the plumbing code, which is covered by Chapter 6 of Plumbing Code, Section

607.2 Hot or Tempered Supply to Fixtures and requires maximum developed length of 50 feet from source to fixture.
Distance requirement imposes excessive restrictions to the hot water system layout and design. Added return branches and increase pipe sizes for serpentine-like systems will require large up front and maintenance costs as well as require larger recirculation pumps (using more energy) to account for the additional flow, head, and heat loss created from the IECC restrictions. Instead recommend reducing the distance requirement in IPC and indicating that the usage of the space and end flow rates be reviewed to determine appropriate pipe size and application of return branches, etc.

To avoid this, we could follow the following energy code compliance paths: ASHRAE 90.1-2013 compliance path , which does not require this.

Without any revisions, the proposed solutions are either to route recirculating HW mains near the fixtures – which increases the installed cost and recirculating pump energy – or incorporate heat tracing systems for temperature maintenance – which also add initial and operating costs for the heat tracing, power circuits, and additional controls.

Bibliography:
Will not increase or decrease resiliency.

Cost Impact:
Most likely, this proposal would result in overall first cost savings as well as long term savings, especially as they relate to energy efficiency.

E1301.1.1.1-18

VCC: 1301.1.1.1

Proponents: Andrew Grigsby (grigsby.ac@gmail.com)

2015 Virginia Construction Code

Delete without substitution:

~~**1301.1.1.1 Changes to the IECC.** The following changes shall be made to the IECC:~~

1. ~~Change Table C402.4 to read:~~

TABLE C402.4

BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration								
***U*-factor**								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
Skylights								
***U*-factor**	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.

2. Change Section C402.4.3 to read:

C402.4.3 Maximum U-factor and SHGC. The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.4.

The window projection factor shall be determined in accordance with Equation 4-5.

$$PF = A/B \qquad \textbf{(Equation 4-5)}$$

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.

Where the fenestration projection factor for a specific vertical fenestration product is greater than or equal to 0.20, the required maximum SHGC from Table C402.4 shall be adjusted by multiplying the required maximum SHGC by the multiplier specified in Table C402.4.3 corresponding with the orientation of the fenestration product and the projection factor.

3. Add Table C402.4.3 to read:

4. Add an exception to the first paragraph of Section C403.2.4.3 to read:

Exception: Any grease duct serving a Type I hood installed in accordance with Section 506.3 of the International Mechanical Code shall not be required to have a motorized or gravity damper.

5. Add Section C403.2.6.3 to read:

C403.2.6.3 Dwelling unit mechanical ventilation. Mechanical ventilation shall be provided for dwelling units in accordance with the *International Mechanical Code*.

6. Change Section C405.5 to read:

C405.5 Exterior lighting (Mandatory). All exterior lighting, other than low-voltage landscape lighting, shall comply with Section C405.5.1.

Exception: Where approved because of historical, safety, signage, or emergency considerations.

7. Change Section R401.2 to read:

R401.2 Compliance. Projects shall comply with all provisions of Chapter 4 labeled "Mandatory" and one of the following:

1. Sections R401 through R404.
2. Section R405.
3. Section R406.
4. The most recent version of REScheck, keyed to the 2015 *International Energy Conservation Code*.

Note: See REScheck compliance guidance issued by DHCD, available at the Department's website.

8. Delete Section R401.3.

9. Change the ceiling *R*-value and wood frame wall *R*-value categories for Climate Zone "4 exception Marine" in Table R402.1.2 to read:

CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE
38	15 or 13+1[h]

10. Change the ceiling *U*-factor and frame wall *U*-factor categories for Climate Zone "4 except Marine" in Table R402.1.4 to read:

CEILING *U*-VALUE	FRAME WALL *U*-VALUE
0.030	0.079

11. Change Section R402.2.4 to read:

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

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

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

12. 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 R402.4.4.

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.

13. 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:

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA[b]
Shower/tub on exterior wall[c]	The air barrier installed at exterior wall adjacent to showers and tubs shall be installed on the interior side and separate the exterior walls from the showers ortubs.	Exterior walls adjacent to showers and tubs shall be insulated.

b. Structural integrity of headers shall be in accordance with the applicable building code.

c. Air barriers used behind showers and tubs on exterior walls shall be of a permeable material that does not cause the entrapment of moisture in the stud cavity.

14. Change Section R402.4.1.2 and add Sections R402.4.1.2.1, R402.4.1.2.2, and R402.4.1.3 to read:

R402.4.1.2 Air sealing. Building envelope air tightness shall be demonstrated to comply with either Section R402.4.1.2.1 or R402.4.1.2.2.

R402.4.1.2.1 Testing option. The building or dwelling unit shall be tested for air leakage. Testing shall be conducted with a blower door at a pressure of 0.2 inches w.g. (50 Pascals). Where required by the building 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 performed at any time after creation of all penetrations of the building thermal envelope.

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.

R402.4.1.2.2 Visual inspection option. Building envelope tightness shall be considered acceptable when the items listed in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the building official, an approved party, independent from the installer, shall inspect the air barrier.

R402.4.1.3 Leakage rate (Prescriptive). The building or dwelling unit shall have an air leakage rate not exceeding 5 changes per hour as verified in accordance with Section R402.4.1.2.

15. 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.

16. Change Section R403.7 to read:

R403.7 Equipment and appliance sizing. Heating and cooling equipment and appliances shall be sized in accordance with ACCA Manual S or other approved sizing methodologies based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.

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

1. The specified equipment or appliance utilizes multistage technology or variable refrigerant flow technology and the loads calculated in accordance with the approved heating and cooling methodology fall within the range of the manufacturer's published capacities for that equipment or appliance.
2. The specified equipment or appliance manufacturer's published capacities cannot satisfy both the total and sensible heat gains calculated in accordance with the approved heating and cooling methodology and the next larger standard size unit is specified.
3. The specified equipment or appliance is the lowest capacity unit available from the specified manufacturer.

~~17. Change Table R406.4 to read:~~

~~18. Delete Section R503.1.1.1.~~

Reason Statement: Virginia should adopt the 2018 International Energy Conservation Code (IECC) without alteration (viewable at https://codes.iccsafe.org/content/iecc2018). The many efficiency reducing amendments to the 2012 IECC that were adopted into the 2012 USBC should be eliminated. Those amendments increased costs for new homebuyers and Virginia as a whole. Researchers at US Dept. of Energy national labs found that, on average, implementing the provisions of the 2012 IECC would have been cash positive for new homebuyers from the first month of occupation, which has caused a drain on our economy and human well-being ever since. Virginia routinely adopts the full IECC for commercial buildings but made a fairly radical departure from the residential IECC during the 2012 code update cycle. We have gradually incorporated aspects of the 2012 IECC since then (note that the 2018 Residential IECC has only minor changes relative to the 2012), and now is the time to finish the job and take full advantage of smart efficiency techniques in new homes of all kinds.
Rigorous energy codes are a win for

- energy policy (costs, grid stability, predictability)
- environmental policy (global warming, resource use)

- the construction industry (increase value and quality of their product, more jobs)
- the mortgage industry (32% less risk of default (IMT/UNC report))
- local jobs (framing and insulating don't happen overseas, testing is new work, quality takes time)
- housing affordability (increases predictability of monthly costs and lowers total cost of housing)
- home buyers/renters of all kinds (comfort, savings, predictability, indoor air quality)

Besides, people want it. A 2013 survey by the National Association of Homebuilders reports that 9 out of 10 homebuyers are willing to pay 2-3% more for a home that includes permanent energy efficiency features.

More on energy and affordability: The Federal Bureau of Labor Statistics and the US Census Bureau report that energy costs for low-income families may represent 10 percent of household income – or more. Rigorous energy codes like the 2018 International Energy Conservation Code (IECC) benefit these families tremendously by helping to create homes with low and predictable energy costs. While it does take a little more up-front capital to build in the provisions of the 2018 IECC, the reduced operating costs more than offset those costs. This benefits low-income and working-class households particularly – as energy costs represent a greater percentage of their income than wealthier folks.

In 2015, the Virginia Tech Center for Housing Research released a study of Earthcraft-certified affordable rental housing in Virginia. This study found that energy usage was approximately 30 percent less in these certified homes compared to similar homes built to the minimum standards of Virginia's building code. These lucky households were saving $54 per month on average—representing 1% to nearly 3% of gross income. That's a big deal for any family struggling to put food on the table.

The homes in the study were low-income projects funded by Virginia's Low Income Housing Tax Credit (LIHTC) program and included blower door testing, among other provisions that exceed Virginia's current code. The costs to implement the above-code elements and achieve Earthcraft certification were managed within the budgets of affordable housing developers. This research was updated in 2017, showing that the affordable housing developments were saving residents an average 45% on their annual energy costs compared to standard housing.

A the 2013 University of North Carolina Center for Community Capital report showed that owners of energy-efficient homes are 32 percent less likely to default on their mortgages. This is incredible, not just for those families, but also for community stability and the overall housing market.

This also highlights a point about other populations for whom energy efficiency is vitally important. Consider the lower middle class, the working class, the "aspirational" homebuyer – families who stretch their budget to get into the best possible new home when they really are one or two missed paychecks from disaster. These folks cannot afford to be surprised by a high energy bill. They are much better off when low energy costs are built into every new home they look at. Then they're much less likely – 32% less likely – to take on more total cost of ownership than they can afford.

The housing industry must consider the total cost of homeownership. With the rigorous efficiency provisions of the 2018 IECC, that cost is reduced – and with that all Virginians enjoy a stronger economy, more stable energy prices, and healthier, more comfortable homes.

SOURCES:

Utility costs as % of income:

- https://www.bls.gov/cex/
- http://www.americaspower.org/sites/default/files/Energy_Cost_Impacts_2012_FINAL.pdf

VT report:

- 2015: https://www.vchr.vt.edu/publications/impact-energy-efficient-design-and-construction-lihtc-housing-virginia
- 2017: https://www.viridiant.org/wp-content/uploads/2018/01/EEC-II-Energy-Cost-Final-Report-1.17.18-1.pdf

UNC report: http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf

cost-effectiveness analyses:

- https://www.mckinsey.com/~/media/McKinsey/dotcom/client_service/Sustainability/PDFs/Reducing%20US%20Greenhouse%20Gas%20Emissic
- http://bcapcodes.org/wp-content/uploads/2015/11/Virginia-2012-IECC-True-Cost.pdf
- http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1194.pdf
- http://bcap-energy.org/wp-content/uploads/2015/12/ICF-Comparison-of-Cost-effectiveness-Methodologies.pdf
- http://www.homeinnovation.com/~/media/Files/Reports/Percent%20Energy%20Savings%202012%20IECC%20Cost%20Effectiveness%20Analy
- US DOE's cost-effectiveness analysis of the 2012 IECC for Virginia: https://www.energycodes.gov/analysis-previous-residential-codes
- US DOE's cost-effectiveness analysis of the 2015 IECC for Virginia: https://www.energycodes.gov/residential-energy-cost-savings-analysis
- US DOE's cost-effectiveness analysis of the 2018 IECC: https://www.energycodes.gov/development/determinations

Bibliography: This proposal will increase Resiliency

RESILIENCY IMPACT STATEMENT

Improving new homes' energy performance will have an enormously positive effect on resiliency in Virginia. The key concept for understanding the resiliency of homes is "passive survivability". When the power is out, a better insulated home will maintain temperature better. It will tend to track the average daily ambient temperature rather than swinging to extreme lows and highs. This helps keep homes habitable during natural disasters. As those disasters become more frequent and more severe, we need to have homes that are better equipped to enable residents to stay healthy through a power outage. And we need all homes to be more efficient in order to minimize the chance of power shortages.

The public health and economic shocks of the global Coronavirus pandemic provide yet another reminder that we must take resiliency and sustainability seriously. As people around the world shelter in place and many folks' incomes (especially the poor and working class) are slashed, passive survivability becomes as salient as during a hurricane or wildfire. We have the technology now to build homes that will better withstand disasters and provide better shelter during public health emergencies. What's more, if built smartly from the beginning, these homes provide lower total cost of ownership for occupants. And all of that smart building directs more economic activity to local builders, suppliers, and lenders. Yes, there is a learning curve for integrating high-performance design, but the benefits to the homebuilding industry and to their consumers and to society at large are well worth doing that learning sooner rather than later.

Cost Impact: The code change proposal will increase the cost of construction
It is irresponsible to focus exclusively on the cost of construction and ignore the cost of operation. This proposal will increase initial construction costs but it will reduce the total cost of housing for occupants and society. If our concern about cost impact is based on the need to keep housing affordable for Virginians of all income levels, then we must consider operating as well as construction costs.

In 2012, the US DOE estimated the incremental cost of compliance with the 2012 IECC relative to the 2009 USBC as $2138 for a 2400sf home. In all, those energy improvements were calculated as saving an average of $388 per year in energy costs, relative to the 2009 USBC. DOE also calculated the net cost to new home occupants based on energy savings, mortgage cost increases, and other associated costs in the first year of ownership and found that consumers realized an average $272 in net savings annually by using the 2012 IECC. Life-cycle cost savings, averaged across building types, are $5,836 for the 2012 IECC. The 2015 and 2018 versions of the IECC were similarly determined to provide net annual savings for occupants of Virginia homes.

Based on this analysis, the advanced energy codes reduce the cost of housing for Virginians – especially for those in lower income brackets who pay a greater percentage of their income on mortgages, rents, and utilities.

Referenced documents:

- US DOE's cost-effectiveness analysis of the 2012 IECC for Virginia: https://www.energycodes.gov/analysis-previous-residential-codes
- US DOE's cost-effectiveness analysis of the 2015 IECC for Virginia: https://www.energycodes.gov/residential-energy-cost-savings-analysis
- US DOE's cost-effectiveness analysis of the 2018 IECC: https://www.energycodes.gov/development/determinations

EB307.1-18

VEBC: 307.1

Proponents: Kenney Payne, AIA-VA (kpayne@moseleyarchitects.com)

2015 Virginia Existing Building Code

307.1 Reroofing. Materials and methods of application used for recovering or replacing an existing roof covering shall comply with this section and the applicable requirements of Chapter 15 of the VCC.

Exceptions:

1. Roof replacement of roof recover of existing low-slope roof coverings shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section 1507 of the VCC for roofs that provide positive roof drainage.
2. Recovering or replacing an existing roof covering shall not be required to meet the requirement of secondary (emergency overflow) drains or scuppers in Section 1503.4 of the VCC for roofs that provide for positive roof drainage. For the purposes of this exception, existing secondary drainage or scupper systems required in accordance with the VCC shall not be removed unless they are replaced by secondary drains or scuppers designed and installed in accordance with Section 1503.4 of the VCC.
3. Like materials, assemblies or thicknesses shall be permitted for *reroofing* involving the exterior *building* thermal envelope, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in *buildings* of similar occupancy, purpose and location.

Reason Statement: Under the 2012 VRC, reroofing was considered at least a Level 1 alteration (706.2), and as such, Section 707 Energy Conservation would also have applied to all alterations. When reroofing was moved to Chapter 3 of the 2015 VEBC, the connection to the way the existing building code dealt with energy conservation was lost. 2015 VEBC 601.4, Exception was originally intended to address reroofing as well as all alterations. But because reroofing was put in Chapter 3 and as such is not governed by Chapter 6, we need to recapture that original intent.

Therefore, by adding the 2015 601.4, Exception to the 2015 VEBC 307.1 exceptions, we make that reconnection again.

Bibliography:
While the applicant is free to fully comply with the IECC for any reroofing, such compliance may not always be possible due to existing roof-lines, roof drainage, rooftop equipment, etc. So, resiliency could still be achieved to a lesser degree by utilizing the exception because any new materials would still need to comply with the newer ASTM, method, and/or installation requirements.

Cost Impact: The code change proposal will decrease the cost of construction
The code change proposal will decrease cost of construction by allowing the use of the exception. For example, full compliance with the IECC might require 6" of rigid insulation. The existing insulation may only be 1" thick. The reroofing may only involve a few squares and/or be spread throughout the entire roof (part here, part there). In those instances, the owner would be left with 6" in some places and 1" in others. That will most likely affect the existing roof drainage and/or crickets at equipment and/or existing edges of the roof (a gravel stop may have been used and now the building height just grew 5"). The cost to revise the roof drainage and roof edge would not be required if the exception were allowed.

EB307.8(2)-18

VEBC: SECTION 307, 307 (New)

Proponents: Justin Koscher, Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org); Jeff mang (jeff.mang@hoganlovells.com); Eric Lacey (eric@reca-codes.com)

2015 Virginia Existing Building Code

SECTION 307
REROOFING AND ROOF REPAIR

Revise as follows:

307 New Code Section 307.8 Energy conservation. *Roof replacements* shall comply with Section C503 of the *International Energy Conservation Code* where the replacement work comprises more than 50 percent of the total roof area or more than 2,000 square feet of roof area, whichever is less.

Reason Statement: This proposal clarifies that roof replacements must comply with the energy conservation requirements of Chapter 13 of the Virginia Construction Code (VCC). The current VCC adopts, with amendments, the International Energy Conservation Code (IECC). The VCC's adoption of the IECC includes adoption of Chapter 5, which describes the energy conservation requirements for building alterations such as roof alterations.
This proposal is necessary because the Virginia Existing Building Code (VEBC) regulates reroofing and roof repair under Section 307. The International Existing Building Code (IEBC) requirements for energy conservation were inadvertently lost when the requirements for reroofing and roof repair were moved to a separate section. This proposal corrects this oversight and clarifies the intent of the VEBC that roof replacements comply with the energy conservation requirements of the Chapter 13 of the VCC (i.e., the IECC as amended by the VCC).

This clarification is important because roof replacements provide a cost-effective means for increasing the energy efficiency of existing buildings. Replacing a typical existing roof with an energy code-compliant roof reduces whole building energy use by an average of 5.7% (https://www.polyiso.org/resource/resmgr/report/bayer_report.pdf). The energy efficiency requirements for roof replacements have been part of the IECC and IEBC for many cycles. This proposal will clarify existing VEBC requirements for roof replacements and help promote a greater level of compliance.

In response to comments received from participants during past Workgroup 2 and the Energy Sub-Workgroup meetings, the new proposal is intended to replace EB307.8(1)-18 and EB307.8(2)-18. During these meetings, various stakeholders expressed interest in adding a threshold to ensure that the requirements would not apply to replacements that involve only a relatively small area of the roof. The threshold language added with this new proposal is the same threshold that has been in use under the California building energy code, section 141.0(b)2B, since at least the 2008 Standards. And, of course, the "roof replacement" requirements do not apply in the case of a "roof recover" (i.e., where a new membrane is installed on top of an existing membrane) or "roof repair."

Bibliography: This proposal will increase Resiliency
This proposal clarifies existing requirements of the Virginia Existing Building Code. Therefore, the proposal will increase resiliency through improved compliance. The practice of energy code-compliant roof replacements increases the resiliency of existing buildings and also responds to the Governor's interest in "identifying and suggesting resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update" (Executive Order 24, November 2018: https://www.governor.virginia.gov/media/governorvirginiagov/executive-actions/ED-24-Increasing-Virginias-Resilience-To-Sea-Level-Rise-And-Natural-Hazards.pdf). Following a power outage or fuel interruption, thermal envelopes that are in compliance with, or superior to, the latest building energy codes are better able to maintain survivable temperatures for longer periods of time or with less demand on back-up power generation. This thermal resiliency attribute is recognized under the LEED pilot credits for resilient design (Credit #100) for maintaining functionality in a building that loses power (https://www.usgbc.org/sites/default/files/LEED-Resilient-Design-Pilot-Credits-Brief-FINAL.pdf).

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This proposal is a clarification of existing requirements and will not increase or decrease the cost of construction.

EB402.1.4.2-18

IECC®: C402.1.4.2 (New), C402.1.4.2.1 (New), C402.1.4.2.2 (New), C402.1.4.2.3 (New), C402.2.1, C402.2.1.1 (New), C402.2.1.2 (New), C402.2.1.3 (New), C402.2.1.4 (New), C402.2.1.5

Proponents: Jeff Mang, Polyisocyanurate Insulation Manufacturers Association (jeff.mang@hoganlovells.com)

2018 International Energy Conservation Code

Add new text as follows:

1 C402.1.4.2 New Code Section Roof/Ceiling Assembly. The maximum roof/ceiling assembly *U* -factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.

1.1 C402.1.4.2.1 New Code Section Tapered, above-deck insulation based on thickness. Where used as a component of a maximum roof/ceiling assembly *U* -factor calculation, the tapered roof insulation *R* -value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R* -value-per-inch (per-mm) for *U* -factor compliance as prescribed in Section C402.1.4.

1.2 C402.1.4.2.2 New Code Section Suspended ceilings. Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U* -factor of the roof/ceiling construction.

1.3 C402.1.4.2.3 New Code Section Multiple layers and staggered joints. Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered. Multiple layers and staggered joints are not required where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

Revise as follows:

C402.2.1 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 C402.1.3, based on construction materials used in the roof assembly. ~~Insulation installed on a suspended ceiling having removable ceiling tiles shall not be considered as part of the minimum thermal resistance of the roof insulation. Continuous insulation board shall be installed in not less than 2 layers and the edge joints between each layer of insulation shall be staggered.~~

~~**Exceptions:**~~

1. ~~Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table C402.1.3.~~
2. ~~Where tapered insulation is used with insulation entirely above deck, the *R*-value where the insulation thickness varies 1 inch (25 mm) or less from the minimum thickness of tapered insulation shall comply with the *R*-value specified in Table C402.1.3.~~
3. ~~Two layers of insulation are not required where insulation tapers to the roof deck, such as at roof drains.~~

Add new text as follows:

1.1 C402.2.1.1 New Code Section Tapered, above-deck insulation based on thickness. Where used as a component of a roof/ceiling assembly *R* -value calculation, the tapered roof insulation *R* -value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R* -value-per-inch (per-mm) for *R* -value compliance as prescribed in Section C402.1.3.

1.2 C402.2.1.2 New Code Section Minimum thickness, lowest point. The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be no less than 1 inch (25 mm).

1.3 C402.2.1.3 New Code Section Suspended ceilings. Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (*R* -value) of roof insulation in roof/ceiling construction.

1.4 C402.2.1.4 New Code Section Multiple layers and staggered joints. Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered. Multiple layers and staggered joints are not required where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

~~**C402.2.1.1**~~ **C402.2.1.5 Skylight curbs.** Skylight curbs shall be insulated to the level of roofs with insulation entirely above the deck or R-5, whichever is less.

Exception: Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

Reason Statement: This proposal adds missing text to Section C402.1.4 and clarifies that the U-factor compliance method is acceptable for roof/ceiling assemblies. The new text is modeled after existing text in Section C402.2. This proposal also clarifies how to calculate the U-factor contribution of tapered roof insulation, which is an important component of new and replacement roof systems. This proposal also clarifies the

existing requirements in Section C402.2 by reorganizing the text into a series of easy-to-follow subsections. The original text was presented as exceptions to the general requirement; however, this added confusion to the code. The revised format will improve compliance and enforcement, as well as make the task of calculating the tapered insulation component R-value easier. Overall, this proposal is intended to simplify the code, add clarity to users and code officials, and improve the ability of building owners to use tapered insulation for U-factor and R-value compliance.
This same proposal was adopted as part of the 2021 I-Codes at the recent Public Comment Hearings in Nevada.

Bibliography: This proposal will increase Resiliency
Building energy efficiency can have a quantifiable impact on resiliency. To the extent that this proposal's clarifications will improve compliance and enforcement of the energy code, this proposal will result in improved building energy efficiency (especially for existing buildings undergoing a roof replacement) and will therefore improve resiliency.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This proposal does not add any new requirements to the energy code. To the extent this proposal makes it easier for building owners to use tapered insulation to satisfy the U-factor or R-value requirements, the cost of construction may decrease.

EB601.4(1)-18

VEBC: 601.4

Proponents: Eric Lacey, Responsible Energy Codes Alliance (eric@reca-codes.com)

2015 Virginia Existing Building Code

601.4 Energy conservation. Level 1, 2, and 3 *alterations* to *existing buildings*, ~~or *structures* are permitted without requiring the entire *building* or *structure* to comply with the energy requirements of the International Energy Conservation Code or International Residential Code . The *alterations* shall conform to the energy requirements of the International Energy Conservation Code or International Residential Code as they relate to new construction only.~~ building systems, or portions thereof shall conform to Section C503 or R503 of the International Energy Conservation Code, without requiring the unaltered portions of the existing building or building systems to comply with this code.

> ~~**Exception:** Except for window and door openings, like materials, assemblies or thicknesses shall be permitted for *alterations* involving the exterior *building* thermal envelope, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in *buildings* of similar occupancy, purpose and location.~~

Reason Statement: The purpose of this proposal is to clarify the applicability of the energy code requirements to existing buildings in the context of an alteration. This will eliminate a conflict between the Virginia Existing Building Code (VEBC) and the Virginia Uniform Code, simplifying compliance and enforcement. It will also reduce energy costs for building owners and improve energy efficiency and resiliency in existing buildings.
This proposal makes two key changes. First, it eliminates a Virginia-specific exception to the energy conservation requirements of Chapter 13 of the Virginia Construction Code (VCC) for certain building envelope alterations. This exception can be misinterpreted to cover a broad range of alterations, and conflicts with the energy code's specific efficiency requirements for existing building alterations. Second, the proposal adds references to the IECC's provisions for existing residential (R503) and commercial (C503) building efficiency. It also clarifies that unaltered portions of the building need not comply with the current energy code requirements.

The importance of minimum energy efficiency requirements for alterations is widely acknowledged and is critical to maintaining and improving Virginia's large population of existing buildings. Addressing alterations through the IECC is cost-effective because the IECC takes advantage of the natural cycle of building renovations and component replacement. Under the IECC, certain alterations provide an opportunity for energy-efficiency improvements specific to existing buildings, but Sections R503 and C503 clarify when the energy code applies and when it does not. These sections include very detailed lists of requirements and exceptions that the VEBC currently lacks.

For example, the IECC requires that wall cavities exposed during alternations be filled with insulation (*see* IECC Section 503.1 Exception 3). Importantly, the IECC does not require that the existing wall framing be altered in order to accommodate R-values specified for new construction. The IECC also does not require any upgrades to unaltered portions of the existing building. Additionally, while separately regulated under Section 307 of the VEBC, reroofing is subject to specific provisions that require additional insulation only for roof replacements where insulation is installed entirely above deck. The IECC contemplates the unique circumstances of existing buildings and provides a detailed set of requirements and exceptions for code users.

This proposal provides users of the VEBC with clear requirements for building alternations, eliminates confusion around how the IECC requirements apply to existing buildings, and addresses concerns raised in the previous code update cycle. The current exception under VEBC Section 601.4 creates an overly broad exception that could be interpreted to cover nearly any alternation to an existing building thermal envelope. We do not think that is consistent with Virginia's energy conservation or resiliency goals.

During the previous code update cycle, it was suggested that the energy code requirements related to envelope alterations are overly expensive or not cost-effective. In fact, the opposite is true. As discussed above, the IECC tailors the requirements for existing buildings to avoid undue costs and unnecessary burdens. Additionally, code officials have the authority to grant variances on a case-by-case basis where there are genuine difficulties and no cost-effective solutions. It was also argued that these energy efficiency requirements would “discourage rehabilitation of many older structures” would be “contrary to the intent set forward by the Virginia Legislative body.” This argument ignores the fact that both the IEBC and IECC have been developed with the express principle of balancing the costs involved with maintaining existing building and other public policies. These other public policies include reducing the amount of energy consumed by existing buildings in order to lower operating costs for owners and stabilize the cost of energy overall for consumers by addressing demand.

Moreover, the proposal above aligns with recommendations in the “Virginia Energy Efficiency Roadmap” published by the Department of Mines, Minerals, and Energy in December 2017, which highlighted the general problem of Virginia adopting weakening amendments to the model energy code and recommended that the state strive to avoid this in the future (*see* page 23, https://www.dmme.virginia.gov/de/LinkDocuments/VAEERM%20FinalRoadmap_20180327.pdf). This proposal would align the VEBC with the IECC's requirements as they apply to existing buildings.

The energy conservation requirements in the IEBC and IECC for alterations are designed to balance the interests involved in renovating an existing building or replacing an existing component with the economic impacts on the building owners. The natural replacement cycle of components provides for cost-effective opportunities to improve building energy efficiency. It is critical that these requirements be internally consistent and easy

to understand, so that Building Code Officials and homebuilders understand them. The proposal above removes an overly broad, confusing, and unnecessary exemption in the current code that creates a conflict among Virginia's code requirements and leaves significant energy and cost savings on the table.

Bibliography: This proposal will increase Resiliency
This code change proposal is also responsive to the Governor's interest in "identifying and suggesting resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update," as stated in Executive Order 24 from November 2018 (https://www.governor.virginia.gov/media/governorvirginiagov/executive-actions/ED-24-Increasing-Virginias-Resilience-To-Sea-Level-Rise-And-Natural-Hazards.pdf). Following a power outage or fuel interruption, thermal envelopes that are in compliance with or superior to the latest building energy codes are better able to maintain survivable temperatures for a longer period or with less demand on potential back-up power generation. This thermal resiliency attribute is recognized under the LEED pilot credits for resilient design, credit #100, for maintaining functionality in a building that loses power (https://www.usgbc.org/sites/default/files/LEED-Resilient-Design-Pilot-Credits-Brief-FINAL.pdf).

Cost Impact:
This proposal would increase the cost of certain alterations to the building envelope. However, the additional efficiency measures would result in improved thermal envelopes and lower building operating costs (*e.g.,* saving an average of 5.7% in energy cost for roof replacements alone), thus recouping the original cost and pay dividends over a very long period of time. Also, these envelope improvements will have additional future economic benefits for the building owner as a result of the reduced heating and cooling loads and the opportunity to use smaller, less expensive HVAC equipment when such equipment is due to be replaced.

EB601.4(2)-18

VEBC: 601.4, 601.4.1 (New)

Proponents: Jeff Mang, Polyisocyanurate Insulation Manufacturers Association (jeff.mang@hoganlovells.com); Kenney Payne, AIA Virginia (kpayne@moseleyarchitects.com)

2015 Virginia Existing Building Code

601.4 Energy conservation. Level 1, 2, and 3 *alterations* to *existing buildings* or *structures* are permitted without requiring the entire *building* or *structure* to comply with the energy requirements of the International Energy Conservation Code or International Residential Code . The *alterations* shall conform to the energy requirements of the International Energy Conservation Code or International Residential Code as they relate to new construction only.

Exception: Except for roofs with insulation entirely above deck and window and door openings, like materials, assemblies or thicknesses shall be permitted for *alterations* involving the exterior *building* thermal envelope, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in *buildings* of similar occupancy, purpose and location.

Add new text as follows:

1 601.4.1 New Code Section Roof replacement Roof replacements shall comply with Section C402.2.1 and Section C402.1.3, C402.1.4, C402.1.5 or C407 of the VECC where all of the following conditions are met. For purposes of this section, roof area shall mean an area of the existing roof of the same building that is bounded by exterior walls, different roof levels, roof edges or perimeters, roof dividers, building expansion joints, or parapets.

1. The roof replacement exceeds 75% or 30,000 square feet (2787.1 m^2) of the roof area, whichever is less.

2. The roof assembly is part of the building thermal envelope, as defined by the VECC.

3. The roof assembly contains insulation entirely above the roof deck.

Reason Statement: This proposed amendment clarifies and improves the enforceability of the requirement under the Virginia Existing Building Code (VEBC) and the Virginia Energy Conservation Code (VECC) that certain replacement work on commercial, low-slope roofs, where the insulation is entirely above the roof deck, must comply with the energy conservation requirement for new construction. The proposed amendment is consistent with the current International Energy Conversation Code (IECC) with the exception that the requirement is triggered based on the relative size of the roof replacement project. The requirement applies where more than 75% or 30,000 sq. ft. of a roof area, whichever is less, is replaced. The concept of "roof area" is used because a building's roof may contain multiple roof areas. Roof area is defined in the proposed amendment. Furthermore, the requirement does not apply to roof repairs and roof recovers, which is consistent with the scope of the IECC requirement.

The roof replacement size threshold is intended to ensure that the energy requirements apply only to replacements that involve a significant portion of the existing roof area and thereby does not apply to work that involves only minor sections of the roof. Also, roof repairs, roof recovers, and roof replacements where the insulation is not located above the deck are not subject to the energy conservation requirements under this amendment. The threshold is intended to avoid scenarios where the energy efficiency requirements might be triggered when only a portion of the roof is being replaced, but the "untouched" portion is still significant. For example, if a roof replacement includes the addition of 2.6 inches of insulation to bring an R-15 roof up to R-30 requirements, the roof area that was intended to remain "untouched" may have to be replaced as well in order to have uniform and positive drainage over the entire roof. The proposed threshold is intended to help avoid these situations.

The threshold applies to areas of the roof that are separated or partitioned from the rest of the roof. For smaller buildings, the roof may not have separate areas, in which case the threshold would apply to the entire roof. However, it is common for larger roofs or roofs with odd configurations, such as roofs on high schools and malls, to be divided into many separate areas which may have different ages, surface heights, and drainages. In fact, for many areas of the country, roof area dividers for BUR, modified bitumen and adhered single-ply membrane systems are generally required at 150 to 200-foot intervals to minimize the buildup of thermal stresses (expansion and contraction). Replacing the roof for just one of these areas and complying with the energy requirements should have no effect on the decision to replace the roof membrane on the other individual roof areas for the same building.

The 30,000 sq. ft. backstop to the 75% threshold is intended to deal with very large roof areas where the building owner may decide to replace that area as two separate jobs, both representing less than 75% of the relevant roof area. For very large roof areas, the use of roof area dividers provides an easy, low-cost solution for a building owner that wants to replace half of a very large roof area one year then replace the other half the next year and still increase the R-value of the roof. Under this scenario, energy is saved and the building owner is not required to replace or "retrofit" the portion of the roof area that was intended to be

left for replacement in the future. The 30,000 sq. ft. backstop is set at a level that is large enough that dividing the roof area into two separate areas will not interfere with the existing roof drainage.

Bibliography: This proposal will increase Resiliency

Building energy efficiency can have a quantifiable impact on resiliency. To the extent that this proposal's clarifications will improve compliance and enforcement of the energy code, this proposal will result in improved building energy efficiency (especially for existing buildings undergoing a roof replacement) and will therefore improve resiliency.

Cost Impact: The code change proposal will not increase or decrease the cost of construction

This proposal is a clarification of existing requirements under the VEBC section 307 (roof replacements) and the VECC section C503.3.1 (roof replacements), so outside of improved compliance, it will not increase or decrease the cost of construction.

EB601.4(3)-18

VEBC: 601.4

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

2015 Virginia Existing Building Code

601.4 Energy conservation. ~~Level 1, 2, and 3~~ Except as modified by this section, *alterations* to an *existing ~~buildings~~ building, building system*, ~~or~~ ~~*structures* are permitted without requiring the entire *building*~~ or *structure* shall conform to the applicable provisions of the Virginia Energy Conservation Code or Virginia Residential Code as they relate to new construction without requiring the unaltered portions of the existing *building*, *building system*, or *structure* to comply with the VECC or VRC. Only the alterations themselves are required to conform to the applicable energy requirements of the ~~International Energy Conservation Code or International Residential Code . The *alterations* shall conform to the energy requirements of the International Energy Conservation Code or International Residential Code as they relate to new construction only~~. VECC or VRC.

Exception: ~~Except for window and door openings, like materials, assemblies or thicknesses shall be permitted for *alterations* involving the exterior *building* thermal envelope, provided no hazard to life, health or property is created. Hazardous materials shall not be used where the code for new construction would not permit their use in *buildings* of similar occupancy, purpose and location.~~

601.4.1 Opaque Walls. Where the existing stud wall cavity that is part of the thermal envelope is exposed during the alteration, such exposed cavities between framing members shall be filled with insulation having a minimum nominal value of ≥R-3.0/inch or filled to the minimum prescriptive insulation requirement in Table R402.1.2 or Table C402.1.3 of the VECC.

Exception: Where less than 60 square feet (5.574 m^2) of the existing stud cavities that are part of the thermal envelope is exposed.

601.4.2 Floors. Where the existing framed floor cavity that is part of the thermal envelope is exposed during the alteration, such exposed cavities between framing members shall be filled with insulation having a minimum nominal value of ≥R-3.0/inch or filled to the minimum prescriptive insulation requirement in Table R402.1.2 or Table C402.1.3 of the VECC.

Exception: Where less than 60 square feet (5.574 m^2) of the existing framed floor cavities that are part of the thermal envelope is exposed.

601.4.3 Ceilings and vented attics. Where the existing rafter cavity that is part of the thermal envelope is exposed during the alteration, such exposed cavities between framing members shall be filled with insulation having a minimum nominal value of ≥R-3.0/inch or to the minimum prescriptive insulation requirement in Table R402.1.2 or Table C402.1.3 of the VECC. Where the existing framed floor or truss bottom chord cavity of a vented attic is exposed during the alteration, the exposed cavities shall be filled with insulation having a minimum nominal value of ≥R-3.0/inch or filled to the minimum prescriptive insulation requirement in Table R402.1.2 or Table C402.1.3 of the VECC. If the existing insulation laying on such vented attic floor is removed, such insulation shall be replaced with insulation complying with the minimum prescriptive insulation requirement in Table R402.1.2 or Table C402.1.3 of the VECC.

Exception: Where less than 60 square feet (5.574 m^2) of the existing rafter, framed vented attic floor, or truss bottom chord cavities that are part of the thermal envelope is exposed.

601.4.4 Fenestration. Where an existing fenestration unit is replaced, the replacement fenestration unit shall comply with the requirements for U-factor and SHGC as specified in Table R402.1.2 or Table C402.4 of the VECC, as applicable. Where more than one fenestration unit is to be replaced, an area-weighted average of the U-factor, SHGC or both of all replacement fenestration units shall be permitted.

601.4.4.1 Converting fenestration unit to opaque wall. Where existing fenestration units are converted into an opaque exterior wall assembly, the new portion of wall shall comply with Section 601.4.1.

601.4.5 Roof replacement . Roof replacements shall comply with Section C402.2.1 and Section C402.1.3, C402.1.4, C402.1.5 or C407 of the VECC where all of the following conditions are met. For purposes of this section, roof area shall mean an area of the existing roof of the same building that is bounded by exterior walls, different roof levels, roof edges or perimeters, roof dividers, building expansion joints, or parapets.

1. The roof replacement exceeds 75% or 30,000 square feet (2787.1 m^2) of the roof area, whichever is less.

2. The roof assembly is part of the building thermal envelope, as defined by the VECC.

3. The roof assembly contains insulation entirely above the roof deck.

601.4.6 Lighting. Lighting alterations shall comply with Section 601.4.4.1 or 601.4.4.2, as applicable.

601.4.6.1 Commercial Lighting. Altered commercial lighting shall comply with Section C405 of the VECC.

Exception: Alterations that replace less than 10 percent of the luminaires within a space, provided the replacement luminaires do not increase the existing interior lighting power as determined by Section C405.4.1 of the VECC.

601.4.6.2 Residential Lighting. Altered residential lighting shall comply with Section R404 of the VECC.

Exception: Alterations that replace less than 50 percent of the total luminaires within a space, provided the replacement luminaires do not decrease the efficacy of the lighting equipment as required by Section R404.1 of the VECC.

601.4.7 Ducts. In R-5 occupancies, where ducts from an existing heating and cooling system are extended, such duct systems with less than 40 linear feet (12.19 m) in unconditioned spaces shall not be required to be tested in accordance with Section R403.3.3 of the VECC.

Reason Statement: This proposal would improve the Virginia Existing Building Code by providing important details about efficiency requirements that apply to common alterations to existing buildings. Virginia's codes currently contain efficiency requirements for existing buildings in two places: The VECC Chapters C5 and R5, and VEBC Section 601.4. In the International Codes, the 2018 International Existing Building Code simply references the International Energy Conservation Code (Chapters C5 and R5) for efficiency requirements, so that the two codes are consistent. Virginia's Energy Conservation Code largely adopts the IECC provisions for existing buildings into the VECC; however, the 2015 VEBC includes only a summary version of these efficiency requirements and does not reference the VECC at all. The result is that Virginia has two sets of efficiency requirements that may not be directly contradictory, but that provide differing levels of specificity. This has created unnecessary confusion among building code officials.
This proposal summarizes the efficiency requirements for the most common alterations to existing buildings and adds these details to VEBC 601.4. It also addresses common situations identified by stakeholders throughout the VA code development process. While we would prefer the simpler approach of the I-Codes (where the IECC contains the efficiency requirements and the IEBC simply references the IECC), if Virginia intends to include all existing buildings requirements in the VEBC, it should at least include the provisions contained in this proposal.

This proposal generally follows the principle that if an assembly is not altered, it need not be brought up to current code; however, where assemblies are altered, they should comply with reasonable efficiency improvements that can be incorporated in a straightforward way. None of the requirements would force building assemblies to be more stringent than new construction, and none would force a "retrofit" of a part of the building that is not undergoing alterations.

If the VEBC is amended to include these requirements, the VECC Chapters C5 and R5 could be revised to match this proposal or a simple reference to the VEBC provisions could be added in their place.

Note that proposed section 601.4.5, related to roof replacement, is intended as a placeholder for language being proposed separately in this process. We expect that this section would be modified to reflect whatever changes are approved in the stakeholder discussions related to roof replacement.

Importance of Efficiency in Existing Buildings

It is crucial that Virginia apply a reasonable and consistent set of efficiency requirements for buildings undergoing alteration, but the current VEBC language is not specific enough to make this happen. In a given year, only 1-2% of the building stock is replaced, whereas the remaining 98-99% of buildings, which were built to earlier versions of the codes, continue to consume energy at far higher rates. If Virginia is ever to achieve sustainable energy efficiency or net-zero at some point in its future, improving efficiency in existing buildings must be an integral part of the statewide building codes. It is unrealistic to force retrofits of existing buildings; however, where an alteration is already taking place, Virginia's Existing Building Code and/or Energy Conservation Code should require the alterations to result in improved efficiency where feasible. This proposal provides very specific measures that can be taken—for minimal incremental cost—to improve the efficiency of existing buildings in meaningful ways.

Bibliography: This proposal will increase Resiliency
This proposal is unique in that it will make existing buildings more resilient and will help VA address broader resiliency concerns due to a changing climate. These improvements fall squarely within the Governor's directive to the Department of Housing and Community Development to identify "resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update," in Executive Order 24 from November 2018.

At the macro level, buildings currently account for over 40% of the nation's energy use and over 70% of the nation's electricity use. A significant portion of that electricity comes from burning fossil fuels, which is one of the causes of climate change. Improvements in efficiency – particularly peak electric demand reductions – will help curb Virginia's need to build and site peak generation (which tends to be both more expensive and more carbon-intensive).

At the building-specific level, improvements to the building's thermal envelope will improve the resiliency of Virginia's buildings. For example, efficient windows maintain better occupant comfort by reducing the volatility of indoor temperature swings. Moreover, these windows will help maintain more livable conditions during power outages due to natural emergencies. Efficient fenestration is designed to reduce both heating and cooling demand, reducing the need to build and site peak generation, resulting in benefits to building owners and all of Virginia's citizens.

Energy codes are increasingly being recognized as playing a role in maintaining resilience and passive survivability, particularly during extended power outages. A recent white paper released by the International Code Council (ICC) and the Alliance for National and Community Resilience (ANCR) recommended that **"[a]ny policies, guidance or criteria that includes building codes as a strategy should explicitly incorporate energy codes as a fundamental resilience strategy."** *See* International Code Council, *The Important Role of Energy Codes in Achieving Resilience*, at 15 (Dec. 2019).

Among these resiliency benefits are improved habitability, more grid stability, moisture management, and improved durability of buildings, and others. It is well within Virginia's interests in improving resiliency to a changing climate to reduce energy demand wherever possible.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This proposal is intended to clarify requirements currently contained in VECC Chapters C5 and R5, and to bring them into the VEBC. Overall, we expect the cost impact to be neutral, but we believe owners of residential and commercial buildings will benefit from efficiency requirements that are clearly and consistently applied.

RE402.1.2(1)-18

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

Proponents: Eric Lacey, Responsible Energy Codes Alliance (eric@reca-codes.com)

2015 Virginia Energy Conservation Code

TABLE R402.1.2

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZEDFENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOODFRAME WALL *R*-VALUE	MASSWALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c]WA *R*-VALUE
1	NR	0.75	0.25	30	13	3/4	13	0
2	0.40	0.65	0.25	38	13	4/6	13	0
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]
4 exceptMarine	0.35	0.55	0.40	~~38~~ 49	~~15 or 13+1~~ 20 or 13+5[h]	8/13	19	10 /13
5 andMarine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

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

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

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. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.4

EQUIVALENT *U*-FACTORS[a]

1 0.50 0.75 0.035 0.084 0.197 0.064 0.360 0.4772 0.40 0.65 0.030 0.084 0.165 0.064 0.360 0.4773 0.35 0.55 0.030 0.060 0.098 0.047 0.091c 0.1365 and Marine 4 0.32 0.55 0.026 0.060 0.082 0.033 0.050 0.0556 0.32 0.55 0.026 0.045 0.060 0.033 0.050 0.0557 and 8 0.32 0.55 0.026 0.045 0.057 0.028 0.050 0.055

CLIMATEZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAMEWALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENTWALL *U*-FACTOR	CRAWLSPACE WALL *U*-FACTOR
4 except Marine	0.35	0.55	~~0.030~~ 0.026	~~0.079~~ 0.060	0.098	0.047	0.059	0.065

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

b. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 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. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

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	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	49	20 or 13+5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

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

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

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 N1101.10 and Table N1101.10.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE N1102.1.4 (R402.1.4)

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.026	0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.087 in Zone 4 except Marine, 0.065 in Zone 5 and Marine 4, and 0.057 in Zones 6 through 8.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.7 and Table N1101.7.

Reason Statement: The purpose of this proposal is to improve energy savings and increase homeowner comfort by adopting the ceiling and wall insulation requirements of the 2018 IECC. Improving ceiling insulation from R-38 to R-49 and wall insulation from R-15 or 13+1 to R-20 or 13+5 will make Virginia's energy code consistent with insulation requirements that have been part of the 2012, 2015, and 2018 IECC.

Based on our analysis, we found that **homeowners will benefit from roughly 6% lower energy costs as compared to a home built to Virginia's current energy code**. Using the U.S. Department of Energy's Residential Energy and Cost Analysis Methodology, we calculated the expected costs and savings associated with these improvements for cities in four different regions of Virginia. The results, which are summarized below, show clear life-cycle cost-effectiveness for these improvements in all four cities. (Note that a negative "life cycle cost" indicates cost savings.)

		Simple Payback Analysis			Life Cycle Cost Analysis		
Run Name	Annual % Cost Savings	Marginal Upgrade Cost	Annual Energy Savings	Simple Payback (Years)	Present Value Costs	Present Value Benefits	Life Cycle Cost
Richmond	5.8%	$741	$84	8.8	$1,678	$4,601	-$2,923
Roanoke	6.5%	$741	$101	7.3	$1,678	$5,502	-$3,824
Sterling	6.0%	$741	$104	7.1	$1,678	$5,669	-$3,991
Norfolk	5.5%	$741	$75	9.9	$1,678	$4,108	-$2,431

This analysis assumes upgrades from R-38 to R-49 in attic insulation and R-15 to R-20 in wall insulation. Calculations use the standard DOE prototype home information for a single-family home and costs from BEopt v.2.8. The complete DOE Residential Energy and Cost Analysis Methodology can be found at https://www.energycodes.gov/residential-energy-and-cost-analysis-methodology.

Because most homes will have a useful lifetime of 70 or more years, the fact that this analysis uses 30 years as the basis for a home's useful lifetime means that the energy and cost savings numbers are very conservative. Insulation in walls and ceilings are unlikely to be changed over the building's useful lifetime, and is most cost-effective when installed at initial construction, when equipment and laborers are already present.

We note that the wall insulation R-values in this proposal do not require the use of any specific product, and can be achieved with either 2X4 or 2X6 wall construction. The two values in the prescriptive R-value table are only two 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 (R402.1.4)

- 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 in the Uniform Code to be consistent with the 2018 IRC/IECC, which is important for builders and design professionals who intend to use DOE's free REScheck compliance software. Virginia's reduced insulation requirements, among other weakening amendments in the current Uniform Code, have made compliance via REScheck problematic. 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 maintain consistency with available software compliance programs.

Bibliography: This proposal will increase Resiliency
This proposal will make buildings more resilient by reducing the volatility of indoor temperature swings and maintaining more livable conditions during power outages due to natural emergencies. These improvements fall squarely within the Governor's directive to the Department of Housing and Community Development to identify "resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update," in Executive Order 24 from November 2018.

Cost Impact: The code change proposal will increase the cost of construction
As noted above, this proposal will increase the cost of construction in new homes. According to our analysis, construction costs will increase by about $741 for the average home, but over a 30-year useful life of a home, homeowners will experience a net savings of $2,431-3,991 (depending on the location of the home) for the improvements in wall and ceiling insulation. It is important to note that initial construction costs are only part of the cost consideration for homeowners. Although the decision whether to insulate to the full IECC values is made only once, homeowners will experience the costs (or benefits) of that decision every month as they pay utility bills. Over a more realistic 70-year useful lifetime of a home, a homeowner will pay 8,400 energy bills, each of which will reflect the impact of that one-time decision to meet the national standard for insulation.

Beyond the monthly costs of heating and cooling homes, high energy bills can have dramatic effects on quality of life.

- The U.S. Energy Information Administration recently reported that nearly one in three households struggle to pay energy bills or to maintain adequate temperatures in their homes every year. Worse, one in five households reported reducing or foregoing basic necessities like food or medicine to pay energy bills. *See* U.S. Energy Information Administration, *Residential Energy Consumption Survey (RECS)*, at https://www.eia.gov/consumption/residential/reports/2015.
- More efficient buildings provide a range of additional health, safety, and welfare benefits, including better indoor environmental quality and increased occupant comfort. *See* U.S. Environmental Protection Agency, *Improving Indoor Air Quality*, at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.), and Efficient Windows Collaborative, at http://www.efficientwindows.org/comfort.php.
- More efficient buildings are also associated with lower foreclosure rates. *See* UNC Center for Community Capital and Institute for Market Transformation, *Home Energy Efficiency and Mortgage Risks* (March 2013), available at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.

Thus, while construction costs and first-year affordability are an important part of the cost/benefit picture, they do not capture the full range of homeowner benefits of a reasonably efficient home.

RE402.1.2(2)-18

VECC: TABLE R402.1.2, TABLE R402.1.4

Proponents: Andrew Grigsby (grigsby.ac@gmail.com)

2015 Virginia Energy Conservation Code

TABLE R402.1.2

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZEDFENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOODFRAME WALL *R*-VALUE	MASSWALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SL/ *F* VAL DE
1	NR	0.75	0.25	30	13	3/4	13	0	
2	0.40	0.65	0.25	38	13	4/6	13	0	
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	
4 exceptMarine	0.35	0.55	0.40	38	~~15~~20 or ~~13+1~~13+5[h]	8/13	19	10 /13	10,
5 andMarine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10,
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10,
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10,

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. “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. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

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. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.4

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAMEWALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENTWALL *U*-FACTOR	CRAWLSPACE 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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.030	~~0.079~~0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 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. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

Reason Statement: The residential portion of the IECC adopted R20/R13+5 insulation thresholds for exterior walls in Climate Zone 4 eight years ago – in 2012. At that time, the US Dept. of Energy (DOE) deemed this level of wall insulation to be a cost-effective strategy that reduced the total cost of ownership (30-year mortgage at 5% plus utilities) in the average new home. The 2015 and 2018 versions of the IECC have the same insulation levels and were similarly deemed cost-effective. This indicates that occupants of new Virginia homes have been unnecessarily wasting energy and money through the last two codes cycles. It's time to correct this defect.
To meet this requirement in a standard 2x6 (nominal) stud wall, the R-value of the cavity insulation must be at least 3.63 per inch. Fiberglass manufacturers offer 5.5-inch-thick high-density R-21 batts that fit a 2x6 wall without compression. Open-cell spray foams are available at R-3.7 per inch. closed-cell polyurethane foam achieves up to R-6 per inch. The R-value of cellulose insulation depends on its density. Denser installations of cellulose have lower levels of air infiltration (but also a lower R-value per inch) than fluffier installations. When installed using the dense-pack method (about 3.5 pounds per cubic foot density), cellulose achieves R-3.65 per inch.

Retrofitting exterior wall insulation is extremely expensive. As Virginia is now set to achieve zero-carbon by 2050 by law, we will need massive investments in energy efficiency. There are many thousands of existing homes that will need major upgrades. We have to stop building new homes that are obsolete from day one.

Minimum insulation requirements are included in the building code to improve health and comfort, reduce operating costs, and help conserve scarce natural resources. Extensive research and field application over the last decade have demonstrated that R20/R13+5 should be the new minimum standard for exterior walls in Virginia's climate zone.

Bibliography: This proposal will increase Resiliency
Improving homes' wall insulation performance will have an enormously positive effect on resiliency in Virginia. The key concept for understanding the resiliency of homes is "passive survivability". When the power is out, a better insulated home will maintain temperature better. It will tend to track the average daily ambient temperature rather than swinging to extreme lows and highs. This helps keep homes habitable during natural disasters. As those disasters become more frequent and more severe, we need to have homes that are better equipped to enable residents to stay healthy through a power outage.

See a good blog on this at https://www.buildinggreen.com/blog/resilient-design-dramatically-better-building-envelopes.

Cost Impact: The code change proposal will increase the cost of construction
If our concern about cost impact is based on the need to keep housing affordable for Virginians of all income levels, then we must consider operating as well as construction costs.

In 2012, the US DOE estimated the incremental cost of compliance with the 2012 IECC relative to the 2009 USBC as $2138 for a 2400sf home. That was the cost for a suite of changes including R-20/13+5 wall insulation. In all, those energy improvements were calculated as saving an average of $388 per year in energy costs, relative to the 2009 USBC. DOE also calculated the net cost to new home occupants based on energy savings, mortgage cost increases, and other associated costs in the first year of ownership and found that consumers realized an average $272 in net savings annually by using the 2012 IECC. Life-cycle cost savings, averaged across building types, are $5,836 for the 2012 IECC. The 2015 and 2018 versions of the IECC were similarly determined to provide net annual savings for occupants of Virginia homes.

Based on this analysis, the advanced energy codes reduce the cost of housing for Virginians – especially for those in lower income brackets who pay a greater percentage of their income on mortgages, rents, and utilities.

Referenced documents:

- US DOE's cost-effectiveness analysis of the 2012 IECC for Virginia: https://www.energycodes.gov/analysis-previous-residential-codes
- US DOE's cost-effectiveness analysis of the 2015 IECC for Virginia: https://www.energycodes.gov/residential-energy-cost-savings-analysis
- US DOE's cost-effectiveness analysis of the 2018 IECC: https://www.energycodes.gov/development/determination

RE402.1.2(3)-18

VECC: TABLE R402.1.2, TABLE R402.1.4, R402.2.2

Proponents: Andrew Grigsby (grigsby.ac@gmail.com)

2015 Virginia Energy Conservation Code

TABLE R402.1.2

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZEDFENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOODFRAME WALL *R*-VALUE	MASSWALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SL *R* VAL DE
1	NR	0.75	0.25	30	13	3/4	13	0	
2	0.40	0.65	0.25	38	13	4/6	13	0	
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	
4 exceptMarine	0.35	0.55	0.40	~~38~~49	15 or 13+1[h]	8/13	19	10 /13	10,
5 andMarine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10,
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10,
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10,

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. “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. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

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. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.4

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAMEWALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENTWALL *U*-FACTOR	CRAWLSPACE 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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	~~0.030~~0.026	0.079	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 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. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

R402.2.2 Ceilings without attic spaces. Where Section R402.1.2 would require insulation levels above R-30 and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. ~~This~~ Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed.This reduction of insulation from the requirements of Section R402.1.2 shall be limited to 500 square feet (46 m^2) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the total UA alternative in Section R402.1.5.

Reason Statement: The residential portion of the IECC adopted the R-49 threshold for attic insulation in Climate Zone 4 in 2012. At that time, the US Dept. of Energy (DOE) deemed this a cost-effective strategy that reduced the total cost of ownership (30-year mortgage at 5% plus utilities) in the average new home. The 2015 and 2018 versions of the IECC have the same insulation level and were similarly deemed cost-effective. This indicates that occupants of new Virginia homes have been unnecessarily wasting energy and money through the last two codes cycles. It's time to correct this defect.
While it's not uncommon to upgrade attic insulation as part of a retrofit, it's not possible in all home designs and it's never as cost-effective. As Virginia is now set to achieve zero-carbon by 2050 by law, we will need massive investments in energy efficiency – and we need to do that in the most cost-effective ways. There are many thousands of existing homes that will need major upgrades. We certainly ought to stop building new homes that are obsolete from day one.

Minimum insulation requirements are included in the building code to improve health and comfort, reduce operating costs, and help conserve precious natural resources. Extensive research and field application over the last decade have demonstrated that R-49 should be the new minimum standard for attics insulation in Virginia's climate zone.

Bibliography: This proposal will increase Resiliency
Improving homes' attic insulation performance will have an enormously positive effect on resiliency in Virginia. The key concept for understanding the resiliency of homes is "passive survivability". When the power is out, a better insulated home will maintain temperature better. It will tend to track the average daily ambient temperature rather than swinging to extreme lows and highs. This helps keep homes habitable during natural disasters. As those disasters become more frequent and more severe, we need to have homes that are better equipped to enable residents to stay healthy through a power outage.

See a good blog on this at https://www.buildinggreen.com/blog/resilient-design-dramatically-better-building-envelopes.

Cost Impact: The code change proposal will increase the cost of construction
This proposal will REDUCE the total cost of housing. If our concern about cost impact is based on the need to keep housing affordable for Virginians of all income levels, then we MUST consider operating as well as construction costs.

In 2012, the US DOE estimated the incremental cost of compliance with the 2012 IECC relative to the 2009 USBC as $2138 for a 2400sf home. That was the cost for a suite of changes including R-49 attic insulation. In all, those energy improvements were calculated as saving an average of $388 per year in energy costs, relative to the 2009 USBC. DOE also calculated the net cost to new home occupants based on energy savings, mortgage cost increases, and other associated costs in the first year of ownership and found that consumers realized an average $272 in net savings annually by using the 2012 IECC. Life-cycle cost savings, averaged across building types, are $5,836 for the 2012 IECC. The 2015 and 2018 versions of the IECC were similarly determined to provide net annual savings for occupants of Virginia homes.

Based on this analysis, the advanced energy codes reduce the cost of housing for Virginians – especially for those in lower income brackets who pay a greater percentage of their income on mortgages, rents, and utilities.

Referenced documents:

- US DOE's cost-effectiveness analysis of the 2012 IECC for Virginia: https://www.energycodes.gov/analysis-previous-residential-codes
- US DOE's cost-effectiveness analysis of the 2015 IECC for Virginia: https://www.energycodes.gov/residential-energy-cost-savings-analysis
- US DOE's cost-effectiveness analysis of the 2018 IECC: https://www.energycodes.gov/development/determinations

RE402.1.2(4)-18

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

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

2015 Virginia Energy Conservation Code

TABLE R402.1.2

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZEDFENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOODFRAME WALL *R*-VALUE	MASSWALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SL *R* VAL DE
1	NR	0.75	0.25	30	13	3/4	13	0	
2	0.40	0.65	0.25	38	13	4/6	13	0	
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	
4 exceptMarine	0.35	0.55	0.40	~~38~~ 49	15 or 13+1[h]	8/13	19	10 /13	10,
5 andMarine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10,
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10,
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10,

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. “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. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

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. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.4

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAMEWALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENTWALL *U*-FACTOR	CRAWLSPACE 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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	~~0.030~~ 0.026	0.079	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 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. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

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	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	~~38~~ 49	15 or 13 + 1[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

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

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

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 N1101.10 and Table N1101.10.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE N1102.1.4 (R402.1.4)

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	~~0.030~~ 0.026	0.079	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.087 in Zone 4 except Marine, 0.065 in Zone 5 and Marine 4, and 0.057 in Zones 6 through 8.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.7 and Table N1101.7.

Reason Statement: The purpose of this proposal is to improve energy savings and increase homeowner comfort by adopting the ceiling insulation requirements of the 2018 IECC. Improving ceiling insulation from R-38 to R-49 will make Virginia's energy code consistent with insulation requirements that have been part of the 2012, 2015, and 2018 IECC.

Based on our analysis, we found that **homeowners will benefit from roughly $10-$14 annual energy cost savings as compared to a home built to Virginia's current energy code**. Using the U.S. Department of Energy's Residential Energy and Cost Analysis Methodology, we calculated the expected costs and savings associated with improving attic insulation from R-38 to R-49 for cities in three different regions of Virginia. The results, which are summarized below, show clear energy cost savings and low first cost in all three cities.

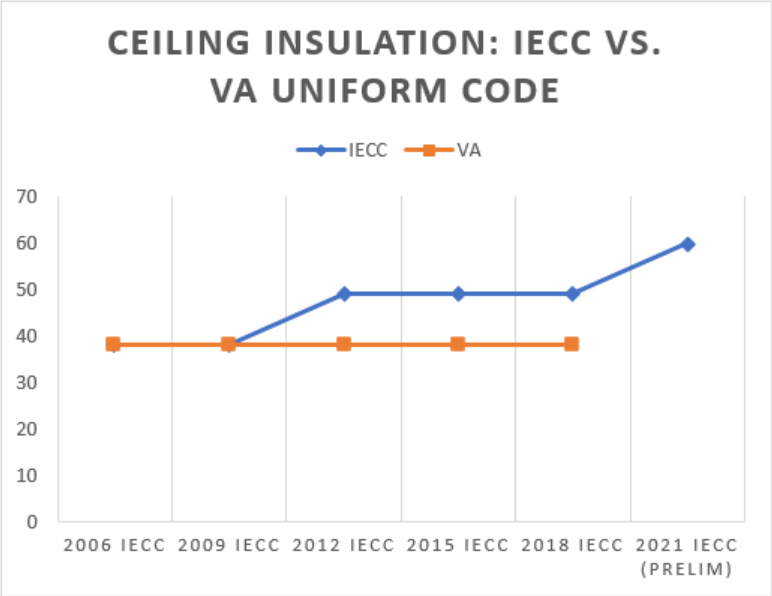
Characteristics and Savings

Run Name	First Cost	Measure Life	Energy Cost Savings
Richmond Ceiling R-49	$215	30	$10
Roanoke Ceiling R-49	$215	30	$13
Sterling Ceiling R-49	$215	30	$14

This analysis assumes attic insulation upgrades from R-38 to R-49. Calculations use the standard DOE prototype home information for a single-family home and costs from BEopt v.2.8. The complete DOE Residential Energy and Cost Analysis Methodology can be found at https://www.energycodes.gov/residential-energy-and-cost-analysis-methodology.

Most homes will have a useful lifetime of 70 or more years, which means the energy cost savings will continue to benefit Virginia homeowners for the life of the home. Insulation in the ceiling is unlikely to be changed over the building's useful lifetime, and is most cost-effective when installed at initial construction, when equipment and laborers are already present.

Virginia has lagged behind the model energy code requirements for ceilings for several cycles now. The R-49 requirement was first incorporated into the 2012 IECC update and has remained at that level in the 2015 and 2018 IECC updates. And while the 2021 IECC has not yet been published, the preliminary results indicate that ceiling insulation will improve further to R-60 for climate zone 4. The following chart shows how Virginia's ceiling R-values have compared with the IECC over the last few code updates:



This proposal also updates the equivalent U-factor in the Uniform Code to be consistent with the 2018 IRC/IECC, which is important for builders and design professionals who intend to use DOE's free REScheck compliance software. Virginia's reduced insulation requirements, among other weakening amendments in the current Uniform Code, have made compliance via REScheck problematic. We recommend that Virginia adopt the equivalent U-factor value that will be consistent with the latest version of the IECC, both to maximize cost-effective energy efficiency and to maintain consistency with available software compliance programs.

It is important to note that although this proposal would improve the prescriptive R-values and U-factors and the overall efficiency of the code, it would not require builders to use a specific R-value or assembly type for ceilings. As with Virginia's current code, builders can use one of the IECC's multiple compliance options to take advantage of efficiency trade-offs where it makes sense. The Total UA path and REScheck offer builders the flexibility to trade efficiency among building envelope components; the Simulated Performance Path and the Energy Rating Index provide even more flexibility for trade-offs.

Bibliography: This proposal will increase Resiliency
This proposal will make buildings more resilient by reducing the volatility of indoor temperature swings and maintaining more livable conditions during power outages due to natural emergencies. These improvements fall squarely within the Governor's directive to the Department of Housing and Community Development to identify "resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update," in Executive Order 24 from November 2018.

Cost Impact: The code change proposal will increase the cost of construction
As noted above, this proposal will increase the cost of construction in new homes. According to our analysis, construction costs will increase by about $215 for the average home, but over a 30-year useful life of a home, homeowners will experience annual energy cost savings of $10-$14 (depending on the location of the home) for the improvements in wall and ceiling insulation. It is important to note that initial construction costs are only part of the cost consideration for homeowners. Although the decision whether to insulate to the full IECC values is made only once, homeowners will experience the costs (or benefits) of that decision every month as they pay utility bills. Over a more realistic 70-year useful lifetime of a home, a homeowner will pay 8,400 energy bills, each of which will reflect the impact of that one-time decision to meet the national standard for insulation.

Beyond the monthly costs of heating and cooling homes, high energy bills can have dramatic effects on quality of life.

- The U.S. Energy Information Administration recently reported that nearly one in three households struggle to pay energy bills or to maintain adequate temperatures in their homes every year. Worse, one in five households reported reducing or foregoing basic necessities like food or medicine to pay energy bills. *See* U.S. Energy Information Administration, *Residential Energy Consumption Survey (RECS)*, at https://www.eia.gov/consumption/residential/reports/2015.
- More efficient buildings provide a range of additional health, safety, and welfare benefits, including better indoor environmental quality and increased occupant comfort. *See* U.S. Environmental Protection Agency, *Improving Indoor Air Quality*, at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.), and Efficient Windows Collaborative, at http://www.efficientwindows.org/comfort.php.
- More efficient buildings are also associated with lower foreclosure rates. *See* UNC Center for Community Capital and Institute for Market Transformation, *Home Energy Efficiency and Mortgage Risks* (March 2013), available at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.

Thus, while construction costs and first-year affordability are an important part of the cost/benefit picture, they do not capture the full range of

homeowner benefits of a reasonably efficient home.

RE402.1.2-18(5)

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

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2015 Virginia Energy Conservation Code

TABLE R402.1.2

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZEDFENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOODFRAME WALL *R*-VALUE	MASSWALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SL/ *F* VAL DE
1	NR	0.75	0.25	30	13	3/4	13	0	
2	0.40	0.65	0.25	38	13	4/6	13	0	
3	0.35	0.55	0.25	38	20 or 13+5[h]	8/13	19	5/13[f]	
4 exceptMarine	0.35	0.55	0.40	38	~~15 or 13+1[h]~~ 20 or 13+5[h]	8/13	19	10 /13	10,
5 andMarine 4	0.32	0.55	NR	49	20 or 13+5[h]	13/17	30[g]	15/19	10,
6	0.32	0.55	NR	49	20+5 or 13+10[h]	15/20	30[g]	15/19	10,
7 and 8	0.32	0.55	NR	49	20+5 or 13+10[h]	19/21	38[g]	15/19	10,

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in climate zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

c. “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. “15/19” shall be permitted to be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home. “10/13” means R-10 continuous insulation on the interior or exterior of the home or R-13 cavity insulation at the interior of the basement wall.

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Climate Zones 1 through 3 for heated slabs.

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. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE R402.1.4

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAMEWALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENTWALL *U*-FACTOR	CRAWLSPACE 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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.030	~~0.079~~ 0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall U-factors shall be a maximum of 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. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

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	0.35	0.55	0.25	38	20 or 13 + 5[h]	8/13	19	5/13[f]	0	5/13
4 except Marine	0.35	0.55	0.40	38	~~15 or 13 + 1[h]~~ 20 or 13 + 5[h]	8/13	19	10/13	10, 2 ft	10/13
5 and Marine 4	0.32	0.55	NR	49	20 or 13 + 5[h]	13/17	30[g]	15/19	10, 2 ft	15/19
6	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	15/20	30[g]	15/19	10, 4 ft	15/19
7 and 8	0.32	0.55	NR	49	20 + 5 or 13 + 10[h]	19/21	38[g]	15/19	10, 4 ft	15/19

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. When insulation is installed in a cavity which is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall not be 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: Skylights may be excluded from glazed fenestration SHGC requirements in Climate Zones 1 through 3 where the SHGC for such skylights does not exceed 0.30.

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

d. R-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.

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 N1101.10 and Table N1101.10.

g. Or insulation sufficient to fill the framing cavity, R-19 minimum.

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

i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

TABLE N1102.1.4 (R402.1.4)

EQUIVALENT *U*-FACTORS[a]

CLIMATEZONE	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	0.35	0.55	0.030	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.35	0.55	0.030	~~0.079~~ 0.060	0.098	0.047	0.059	0.065
5 and Marine 4	0.32	0.55	0.026	0.060	0.082	0.033	0.050	0.055
6	0.32	0.55	0.026	0.045	0.060	0.033	0.050	0.055
7 and 8	0.32	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. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.087 in Zone 4 except Marine, 0.065 in Zone 5 and Marine 4, and 0.057 in Zones 6 through 8.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure N1101.7 and Table N1101.7.

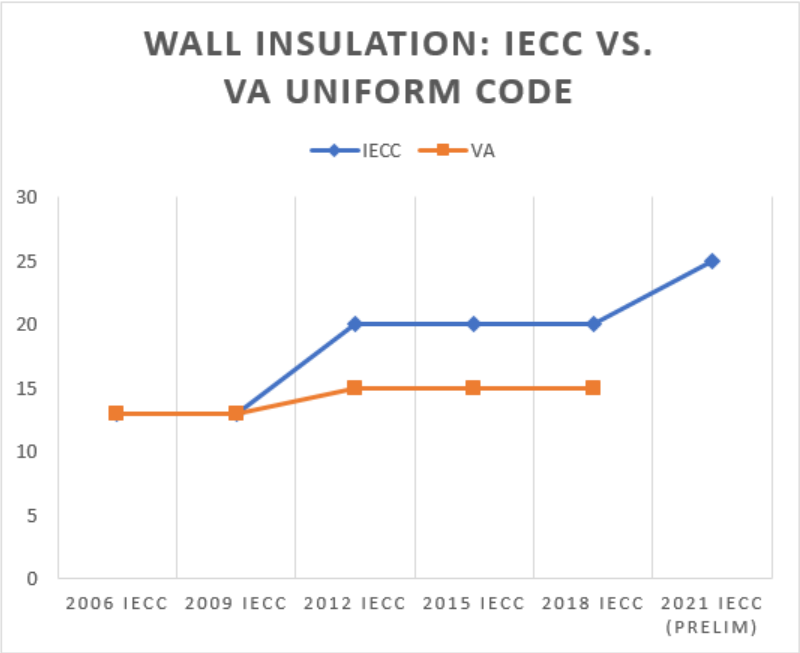
Reason Statement: The purpose of this proposal is to improve energy savings and increase homeowner comfort by adopting the wall insulation requirements of the 2018 IECC. Improving wall insulation from R-15 or 13+1 to R-20 or 13+5 will make Virginia's energy code consistent with insulation requirements that have been part of the 2012, 2015, and 2018 IECC.
Based on our analysis, we found that **homeowners will benefit from roughly $78-$103 annual energy cost savings as compared to a home built to Virginia's current energy code**. Using the U.S. Department of Energy's Residential Energy and Cost Analysis Methodology, we calculated the expected costs and savings associated with improving wall insulation from R-15 to R-20 for cities in three different regions of Virginia. The results, which are summarized below, show clear energy cost savings and low first cost in all three cities.

Characteristics and Savings			
Run Name	**First Cost**	**Measure Life**	**Energy Cost Savings**
Richmond Wall R-20	$399	30	$78
Roanoke Wall R-20	$399	30	$91
Sterling Wall R-20	$399	30	$103

This analysis assumes wall insulation upgrades from R-15 to R-20. Calculations use the standard DOE prototype home information for a single-family home and costs from BEopt v.2.8. The complete DOE Residential Energy and Cost Analysis Methodology can be found at https://www.energycodes.gov/residential-energy-and-cost-analysis-methodology.

Most homes will have a useful lifetime of 70 or more years, which means the energy cost savings will continue to benefit Virginia homeowners for the life of the home. Insulation in walls and ceilings are unlikely to be changed over the building's useful lifetime, and is most cost-effective when installed at initial construction, when equipment and laborers are already present.

Virginia has lagged behind the model code in wall efficiency for multiple update cycles. The 2018 IECC requirement for R-20 or 13+5 wall insulation was first incorporated into the 2012 IECC and has remained in the 2015 and 2018 editions. And while the 2021 IECC has not yet been published, the preliminary results indicate that insulation requirements will further improve. In climate zone 4, wall insulation is expected to improve to R-20+5 or R-13+10. The chart below demonstrates how Virginia has not kept up with the model code R-value requirements for walls.



This proposal also updates the equivalent U-factor in the Uniform Code to be consistent with the 2018 IRC/IECC, which is important for builders and design professionals who intend to use DOE's free REScheck compliance software. Virginia's reduced insulation requirements, among other weakening amendments in the current Uniform Code, have made compliance via REScheck problematic. We recommend that Virginia adopt Equivalent U-factor value that will be consistent with the latest version of the IECC, both to maximize cost-effective energy efficiency and to maintain consistency with available software compliance programs.

It is important to note that this proposal does not mandate a specific R-value or assembly type for walls. As with Virginia's current insulation requirements, builders have broad flexibility to trade efficiency among building envelope components through the Total UA or REScheck path, as well as a broad range of trade-offs through the Simulated Performance Alternative or the Energy Rating Index. While the proposal will improve the overall efficiency of the code, builders will still have a wide range of alternatives to demonstrate equivalent performance.

Bibliography: This proposal will increase Resiliency
This proposal will make buildings more resilient by reducing the volatility of indoor temperature swings and maintaining more livable conditions during power outages due to natural emergencies. These improvements fall squarely within the Governor's directive to the Department of Housing and Community Development to identify "resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update," in Executive Order 24 from November 2018.

Cost Impact: The code change proposal will increase the cost of construction
As noted above, this proposal will increase the cost of construction in new homes. According to our analysis, construction costs will increase by about $399 for the average home, but over a 30-year useful life of a home, homeowners will experience an annual energy cost savings between $78-$103 (depending on the location of the home) for the improvements in wall and ceiling insulation. It is important to note that initial construction costs are only part of the cost consideration for homeowners. Although the decision whether to insulate to the full IECC values is made only once, homeowners will experience the costs (or benefits) of that decision every month as they pay utility bills. Over a more realistic 70-year useful lifetime of a home, a homeowner will pay 8,400 energy bills, each of which will reflect the impact of that one-time decision to meet the national standard for insulation.

Beyond the monthly costs of heating and cooling homes, high energy bills can have dramatic effects on quality of life.

- The U.S. Energy Information Administration recently reported that nearly one in three households struggle to pay energy bills or to maintain adequate temperatures in their homes every year. Worse, one in five households reported reducing or foregoing basic necessities like food or medicine to pay energy bills. *See* U.S. Energy Information Administration, *Residential Energy Consumption Survey (RECS)*, at https://www.eia.gov/consumption/residential/reports/2015.
- More efficient buildings provide a range of additional health, safety, and welfare benefits, including better indoor environmental quality and increased occupant comfort. *See* U.S. Environmental Protection Agency, *Improving Indoor Air Quality*, at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.), and Efficient Windows Collaborative, at http://www.efficientwindows.org/comfort.php.
- More efficient buildings are also associated with lower foreclosure rates. *See* UNC Center for Community Capital and Institute for Market Transformation, *Home Energy Efficiency and Mortgage Risks* (March 2013), available at http://www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.

Thus, while construction costs and first-year affordability are an important part of the cost/benefit picture, they do not capture the full range of homeowner benefits of a reasonably efficient home.

RE402.4.1.3-18

VECC: R402.4.1.3

Proponents: Andrew Grigsby (grigsby.ac@gmail.com)

2015 Virginia Energy Conservation Code

R402.4.1.3 Leakage rate (Prescriptive). The building or dwelling unit shall have an air leakage rate not exceeding ~~5~~ 3 changes per hour as verified in accordance with Section R402.4.1.2.

Reason Statement: The residential portion of the IECC adopted 3ACH (air changes per hour) as the maximum for Climate Zone 4 in 2012. At that time, the US Dept. of Energy (DOE) deemed this a cost-effective strategy that reduced the total cost of ownership (30-year mortgage at 5% plus utilities) in the average new home. The 2015 and 2018 versions of the IECC have the same ACH threshold and were similarly deemed cost-effective. This indicates that occupants of new Virginia homes have been unnecessarily wasting energy and money through the last two codes cycles. It's time to correct this defect.
The most cost-effective time to air-seal a home is during construction. As Virginia is now set to achieve zero-carbon by 2050 by law, we will need massive investments in energy efficiency. There are many thousands of existing homes that will need major upgrades. We have to stop building new homes that are obsolete from day one.

Maximum infiltration thresholds are included in the building code to improve health and comfort, reduce operating costs, and help conserve precious natural resources. Extensive research and field application over the last decade have demonstrated that 3ACH is the appropriate maximum infiltration standard for properly ventilated homes in Virginia's climate zone.

Bibliography: This proposal will increase Resiliency
Improving homes' overall thermal performance has an enormously positive effect on resiliency in Virginia. The key concept for understanding the resiliency of homes is "passive survivability". When the power is out, a better insulated home will maintain temperature better. It will tend to track the average daily ambient temperature rather than swinging to extreme lows and highs. This helps keep homes habitable during natural disasters. As those disasters become more frequent and more severe, we need to have homes that are better equipped to enable residents to stay healthy through a power outage. When mechanical ventilation is unavailable during a power outage, strategic natural ventilation via window and door openings is superior to relying on unpredictable and variable infiltration from unknown sources.

Cost Impact: The code change proposal will increase the cost of construction
This proposal will REDUCE the total cost of housing. If our concern about cost impact is based on the need to keep housing affordable for Virginians of all income levels, then we MUST consider operating as well as construction costs.

If done right the first time, the incremental cost to seal a home to 3ACH versus Virginia's current standard of 5ACH should be negligible. Assuming that more homes will need remedial action given the more rigorous threshold and, particularly, the requirement to actually perform a blower door test, there will be a learning curve that will add time and expense.

In 2012, the US DOE estimated the incremental cost of compliance with the 2012 IECC relative to the 2009 USBC as $2138 for a 2400sf home. That was the cost for a suite of changes including achieving the 3ACH limit. In all, those energy improvements were calculated as saving an average of $388 per year in energy costs, relative to the 2009 USBC. DOE also calculated the net cost to new home occupants based on energy savings, mortgage cost increases, and other associated costs in the first year of ownership and found that consumers realized an average $272 in net savings annually by using the 2012 IECC. Life-cycle cost savings, averaged across building types, are $5,836 for the 2012 IECC. The 2015 and 2018 versions of the IECC were similarly determined to provide net annual savings for occupants of Virginia homes.

Based on this analysis, the advanced energy codes reduce the cost of housing for Virginians – especially for those in lower income brackets who pay a greater percentage of their income on mortgages, rents, and utilities.

Referenced documents:

- US DOE's cost-effectiveness analysis of the 2012 IECC for Virginia: https://www.energycodes.gov/analysis-previous-residential-codes
- US DOE's cost-effectiveness analysis of the 2015 IECC for Virginia: https://www.energycodes.gov/residential-energy-cost-savings-analysis
- US DOE's cost-effectiveness analysis of the 2018 IECC: https://www.energycodes.gov/development/determinations

RE503.1.1.1-18

VECC: R503.1.1.1; VRC: N1109.1.1.1 (R503.1.1.1)

Proponents: Energy Subworkgroup; Eric Lacey, Responsible Energy Codes Alliance (eric@reca-codes.com)

2015 Virginia Energy Conservation Code

R503.1.1.1 Replacement fenestration. ~~(Section deleted.)~~

Where a permit is required, where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC as specified in Table R402.1.2. Where more than one replacement fenestration unit is to be installed, an area-weighted average of the U-factor, SHGC or both of all replacement fenestration units shall be an alternative that can be used to show compliance.

2015 Virginia Residential Code

N1109.1.1.1 (R503.1.1.1) Replacement fenestration. ~~(Section deleted.)~~

Where a permit is required, where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for U-factor and SHGC as specified in Table R402.1.2. Where more than one replacement fenestration unit is to be installed, an area-weighted average of the U-factor, SHGC or both of all replacement fenestration units shall be an alternative that can be used to show compliance.

Reason Statement: This proposal improves efficiency by clarifying that replacement fenestration must meet the same level of efficiency as fenestration used in new construction. This code requirement has been in the IECC for over a decade, and for good reason – about 3/4 of all windows installed in buildings every year are replacement windows in existing buildings. This is a rare opportunity to impact the efficiency of existing buildings – which represent 98-99% of buildings in any given year – by a substantial amount. Code-compliant fenestration is widely available and clearly cost-effective, and there is no reason why Virginia homeowners should not have all the benefits of efficient replacement windows and doors. The 2018 IECC adds a new level of flexibility by allowing replacement fenestration U-factors and SHGCs to be area-weighted averaged, permitting trade-offs among various fenestration types. We expect that this will provide more options for builders and homeowners to meet the code requirement.

In the previous code update cycle, there was some concern expressed about how (and whether) to apply this requirement if a permit is not required for window replacement. This proposal adds the conditional language: “Where a permit is required …” to clarify that replacement fenestration is only required to meet the code requirements when a permit is required in Virginia. The language is otherwise identical to the IECC section.

Bibliography: This proposal will increase Resiliency
This proposal is unique in that it will make existing buildings more resilient. There are very few opportunities to affect Virginia's extensive building stock, but over 3/4 of windows sold in the Commonwealth are used in existing buildings. Efficient windows maintain better occupant comfort by reducing the volatility of indoor temperature swings. Moreover, these windows will help maintain more livable conditions during power outages due to natural emergencies. These improvements fall squarely within the Governor’s directive to the Department of Housing and Community Development to identify “resilience-specific improvements to the Uniform Statewide Building Code (USBC) for inclusion in the 2018 code update,” in Executive Order 24 from November 2018.

At the macro level, buildings currently account for over 40% of the nation’s energy use and over 70% of the nation’s electricity use. A significant portion of that electricity comes from burning fossil fuels, which is one of the causes of climate change. Improvements in efficiency – particularly peak electric demand reductions – will help curb Virginia’s need to build and site peak generation (which tends to be both more expensive and more carbon-intensive). Efficient fenestration is designed to reduce both heating and cooling demand, providing these additional benefits to building owners and all Virginia’s citizens. It is well within Virginia’s interests in improving resiliency to a changing climate to reduce energy demand wherever possible.

Cost Impact: The code change proposal will increase the cost of construction
This proposal will increase construction costs in some cases. However, these efficiency requirements already apply to windows used in new construction, and are no less cost-effective in a replacement context. It is important to keep in mind that the incremental cost increase associated with a slightly more efficient window unit is very small compared to the cost of replacing a home's windows in the first place (a decision the homeowner has already made, and costs the homeowner has already decided to take on). In many cases, the windows selected by homeowners and contractors are likely to be code-compliant or even beyond-code-compliant (such as Energy Star), and in these cases there will be no cost increase. Regardless, it is important for Virginia to set the standard for the efficiency of replacement fenestration installed in existing buildings.