2018 NC Energy Conservation Code and 2018 NC Residential Code Amendment to Energy Rating Index (ERI) Compliance Alternative Method to Include a Reduced R-value for Spray Foam Insulation

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Rule Citation:	2018 NC Energy Conservation Code R406.2 (B-15) 2018 NC Residential Code N1106.2 (B-21)
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Rulemaking Authority:	N.C.G.S. 143-138
Impact Summary:	State Government: No Local Government: No Private Entities: Yes Substantial Impact: Uncertain – substantial impact probable

Introduction and Purpose

The amendment allows builders who choose to follow the Energy Rating Index (ERI) option to substitute R-20 insulation under or above the roof deck in place of attic floor insulation in attics that contain ductwork. This type of attic is called an *unvented attic* and is required to comply with the conditions in R806.5 of the NC Residential Building Code. Note that choosing to utilize the provisions in the amendment is not a requirement, but rather an option within Section 406: Energy Rating Index Compliance Alternative. Hence, the proposed change is actually an option within an option. The ERI would require the builder to conduct an energy modeling study to ensure it complies with the ERI stipulations, which provide a more efficient home than the prescriptive requirements of the energy code.

Impact Analysis

1. Introduction to R-20 Roof Insulation

In traditional construction of attics in North Carolina, the attic is ventilated and the insulation is installed on attics floors rather than the rafter spaces below the roof of the house. In most homes, the attic floor has numerous areas where continuous insulation and air sealing are difficult, such as:

- Around electrical boxes for lighting and exhaust fans
- Over attic hatches and stairs
- In areas where ductwork drops down into the living areas of the home via plenums
- Near the eaves where there is inadequate space between the roof deck and the attic floor
- In areas where the ceiling is not uniformly flat – for example in rooms with tray ceilings or in areas with differing ceiling heights

In the above locations, attic insulation values often fall short of the full energy code requirements – now R-38 throughout the state (except R-30 is allowed if it can be applied with full thickness throughout the attic, which would typically require a roof with a raised heel truss). Insulation depths to achieve R-38 would be about 12 inches and R-30 would be 9 inches.

The typical vented attic in North Carolina also contains ductwork, and in many cases, the inside unit of the HVAC system, which contribute significantly to energy consumption. Applying air impermeable insulation under the rafters of the attic and against the gable end walls would create a sealed attic, which would bring the HVAC system inside the insulation system of the home. In addition, homes insulated with air impermeable products have substantially lower rates of air leakage than standard homes. The air impermeable insulation can be sprayed either as a single layer to provide the full required R-value or as an air impermeable layer above other insulation products, such as fiberglass or rock wool.

The energy savings of the sealed attic approach can be significant. For example, computer modeling of a 2,526 square foot home in Raleigh with an attic HVAC system and 60% of the supply ductwork in the attic and code values for air and duct leakage estimates energy use of 8,030 kWh per year for heating and cooling, while the same home with a R-20 roof deck in a sealed attic uses 7,268 kWh – a savings of 762 kWh per year (9%).

2. Values Used in the Economic Analysis

REMRate[tm] software was used to estimate the energy consumption of two comparison homes in each climate zone – one that met the prescriptive 2018 energy code and another with a sealed attic and R-20 roof deck insulation. For comparison, Ekotrope[tm] software was also used to check the REMRate findings for the two comparison homes in Climate Zone 4. The two software packages produced virtually identical net savings for the R-20 roof deck insulation. Key variables in the analysis that compared a home meeting the 2018 prescriptive energy code to one with R-20 roof deck insulation are as follows:

- Areas and insulating values of all exterior surfaces (floors, walls, ceilings, windows, doors, etc.)
- Percentage of ductwork located in the attic
- Air leakage rates for the homes (measured in air changes per hour when the house is subjected to a pressure of 50 Pascals, as is the standard for conducting a blower door test – abbreviated ACH50). The total conditioned (heated and cooled) volume is greater for the home with the R-20 roof deck since it contains the sealed attic.
- Duct leakage rates for the homes (measured in cubic feet per minute per 100 square feet of conditioned – heated and cooled – floor area in the home when the ductwork is subjected to a pressure of 25 Pascals of pressure during a duct leakage test – abbreviated CFM25/100 sq ft)

The analysis assumes a model home with a total of 2,526 square feet of conditioned area. The home measures 36 feet in width and 41.2 square feet in length. It has 1,043 square feet of conditioned space on the first floor, which is on a concrete slab-on-grade, and a 440 square-foot garage. The second floor, which is under a gable roof, has 1,483 square feet of conditioned space; 440 square feet of the second floor is located above the garage. The gable end walls face the narrower (36-foot) side of the home. The roof has a 7 in 12 pitch -- about a 30% angle. The standard home used in the analysis meets the prescriptive energy code, with R-10 slab insulation in Climate Zones 4 and 5 (and no slab insulation in Climate Zone 3), R-19 floors over the crawl space, R-15 walls, R-30 continuous ceiling insulation (an allowance in place of R-38, which may have less insulation in areas with lower ceiling heights), 5 ACH50 air leakage, and 4 CFM25/ 100 sq ft duct leakage to the exterior.

The comparison home with the R-20 roof deck is identical to the model home, except:

- In the attic there is no R-30 insulation on the attic floor and instead the roof deck has R-20 spray foam insulation.
- The gable end walls in the attic have R-15 insulation in Climate Zones 3 and 4, and R-19 insulation in Climate Zone 5.
- The duct and air leakage rates are lower.

The assumed methods of installing the roof deck and gable end wall insulation are as follows:

- R-20 air impermeable insulation for the roof deck has R-13 in the cavity between the top chords of the roof truss and R-7 covering the interior of the roof trusses and extending across the cavity insulation; R-25 air impermeable insulation in Climate Zone 5 has R-13 in the cavity and R-12 covering the interior of the roof trusses and extending across the cavity insulation.
- R-15 air impermeable insulation for the gable end walls – as assumed in the cost analysis (R-19 batt insulation with 2x6 construction in Climate Zone 5).

The key data values for percentage of ductwork located in the attic, air leakage, and duct leakage are based on two recent surveys of new construction in the state conducted by Appalachian State University. The surveys, part of a research contract with the U.S. Department of Energy, gathered data on 383 new homes. One of the items surveyed was the location of the duct systems in the home. As Table 1 shows, an average of over 60% of the ductwork systems are located in the attic in new homes.

Table 1: Percentage of Ductwork in Attics in North Carolina New Home Survey

	% of Supply Ducts in Attic	% of Return Ducts in Attic	Number in Survey
Survey 1	56.0	55.6	114
Survey 2	64.1	63.4	197
Weighted Average of Both Surveys	61.1	60.5	311

In the two surveys, most of the homes had attic insulation applied to the attic floor. A few homes had air impermeable insulation applied to the roof deck. As shown in Table 2, the results show dramatically lower air leakage and duct leakage values for homes with sealed attics than homes with vented attics and insulation on the attic floor.

Table 2: Comparative Air and Duct Leakage Rates in the North Carolina New Homes Survey

	Homes with Attic Floor Insulation	Homes with Sealed Attics	% Decrease in Homes with Rafter Insulation
Air leakage (air changes per hour at 50 Pascals)	4.22	2.04	52%
Duct leakage to the exterior (cubic feet per minute at 25 Pascals)	2.95	0.79	73%
Number of homes tested	124	5	

Based on these results, the analysis used the following values so that the model home exactly met the prescriptive provisions of the energy conservation code:

Air leakage rate

Model home 5 ACH50

Sealed attic home 2.4 ACH50 (52% less than 5 ACH50); however, the conditioned volume is greater – 30,080 cubic feet instead of 22,294 cubic feet

Duct leakage rate

Model home 4 CFM25 per 100 sq ft = 100 CFM25 for the 2,526 square-foot home

Sealed attic home 1.1 CFM25 per 100 sq ft (73% less than 5 ACH50) = 27 CFM25

It is noted here that opponents of this proposed amendment contend that air leakage should not be considered when determining the financial cost/benefit. Opponents believe that the openings in an attic floor and ductwork in the attic must also meet the same air leakage requirements as provided by spray foam insulation applied to the underside of the roof sheathing and attic walls. The position of the council is that theoretically this is true, but in reality spray foam will overcome installation errors that typically occur with ductwork and attic floor installed insulation as well as maintain an improved reduced air leakage rate over time because of the durability of spray foam. The durability is accomplished because it is not located on the floor of the attic where it is susceptible to damage and because adhesion of the spray foam to the building structure and appurtenances is not affected by changing temperatures and humidity as masking used around joints in ductwork or penetrations of the ceiling can be.

Climate Zone 3 Energy Modeling Results

Table 3 summarizes the results of the analysis for Climate Zone 3 with Charlotte selected as the home's location. The energy consumption for the home with R-20 roof deck insulation dropped by 2.5 million Btu per year – about 4% of total usage. The heating load decreased 24% and the cooling load declined by 12%, which would lower the peak electrical demand for the home.

Table 3: Energy Consumption Comparison in Climate Zone 3

	Climate Zone 3 Analysis			
	Base Code Home	**R-20 Roof Deck Home**	**Differ-ence**	**% Reduction**
Design Loads				
Heating (kBtu/hr)	39.3	29.7	9.6	24%
Cooling (kBtu/hr)	27.4	24.2	3.2	12%
Annual Energy (MMBtu/yr)				
Heating	19.2	17.8	1.4	7%
Cooling	8.8	7.7	1.1	13%
Water Heating	10.6	10.6	0	0%
Lights and Appliances	24.8	24.8	0	0%
Total (MMBtu/yr)	**63.4**	**60.9**	**2.5**	**4%**
Annual Energy Costs ($/yr)				
Heating	$602	$557	45	7%
Cooling	283	246	37	13%
Water Heating	337	337		
Lights and Appliances	789	789		
Service Charge	168	168		
Total	**$2,179**	**$2,097**	**82**	**3.8%**

3. Climate Zone 4 Energy Modeling Results

The characteristics of the home in terms of dimensions, insulation, windows, and other components are identical to those for Climate Zone 3 with the exception of using Raleigh as the site location rather than Charlotte. The results of the analysis are in Table 4. The energy consumption for the home dropped by 2.6 million Btu per year (4%), with similar results for Climate Zone 3 regarding reduction in heating and cooling loads.

Table 4: Energy Consumption Comparison in Climate Zone 4

	Climate Zone 4 Analysis			
	Base Code Home	**R-20 Roof Deck Home**	**Differ-ence**	**% Reduction**
Design Loads				
Heating (kBtu/hr)	37.3	27.3	10	27%
Cooling (kBtu/hr)	28	24.6	3.4	12%
Annual Energy (MMBtu/yr)				
Heating	18.8	17.3	1.5	8%
Cooling	8.6	7.5	1.1	13%
Water Heating	10.9	10.9	0	0%
Lights and Appliances	24.8	24.8	0	0%
Total (MMBtu/yr)	**63.1**	**60.5**	**2.6**	**4%**
Annual Energy Costs ($/yr)				
Heating	587	540	47	8%
Cooling	276	240	36	13%
Water Heating	347	347		
Lights and Appliances	788	788		
Service Charge	168	168		
Total	**$2,166**	**$2,083**	**83**	**3.8%**

4. Climate Zone 5 Energy Modeling Results

For the Climate Zone 5 base home analysis, the following items were altered to reflect the energy code requirements in this colder region of the state:

- R-30 crawl space and over-garage floor insulation
- R-19 above-grade walls

For the roof deck insulation case, the following alterations were made:

- R-25 roof deck insulation
- R-19 gable wall insulation

Table 5 shows the results of the analysis. The energy savings and load reductions are greater than in the other zones.

Table 5: Energy Consumption Comparison in Climate Zone 5

	Climate Zone 5 Analysis			
	Base Code Home	**Foam Roof Deck Home**	**Differ-ence**	**% Reduction**
Design Loads				
Heating (kBtu/hr)	40.1	28.6	11.5	29%
Cooling (kBtu/hr)	22.1	18.7	3.4	15%
Annual Energy (MMBtu/yr)				
Heating	25.3	22.3	3	12%
Cooling	4.3	3.8	0.5	12%
Water Heating	12.5	12.5	0	0%
Lights and Appliances	24.7	24.7	0	0%
Total (MMBtu/yr)	**66.8**	**63.3**	**3.5**	**5%**
Annual Energy Costs ($/yr)				
Heating	$793	$699	94	12%
Cooling	138	122	16	12%
Water Heating	397	397		
Lights and Appliances	785	785		
Service Charge	168	168		
Total	**$2,281**	**$2,171**	**110**	**4.8%**

5. Construction Cost Differences

For Climate Zones 3 and 4, the changes in construction in going from the base model to the insulated roof deck model are as follows:

- No attic floor insulation (1,483 square feet of R-30)
- Uninsulated attic stair (1 opening)
- No attic ridge or soffit vents (one ridge vent and two sets of soffit vents)
- R-4.2 ductwork in place of R-8 ductwork
- Savings on air sealing costs
- Added R-20 (R-25 in Climate Zone 5) roof deck insulation (1,717 square feet)
- Added R-15 gable wall insulation (299 square feet)

Table 6 shows the estimated additional construction costs in Climate Zones 3 and 4. The costs of insulation were obtained from insulation installers in the state and provided by Randy Nicklas of Icynene-LaPolla. The estimated reduction in the cost of ductwork was based on pricing at a HVAC distributor, but the only R-values available were R-8 and R-6. The savings in just the price of ductwork for the sample home was $49. There would conceivably be a decrease in ductwork installation costs as not as many components would have to hang from the ceiling structure, held in place with duct hanging straps, since the attic floor would not require insulation. Because the air barrier system would shift from the attic floor to the roof, there would be a savings in air sealing costs, particularly in the cost of sealing seams between the drywall and top plates in the attic. The cost of applying caulk to these seams ranges from $0.85 to $2.00 per lineal foot according to various sources on the Internet. In the home used for the analysis, there are over 450 lineal feet of seams. The analysis assumed a more conservative (lower) cost of $0.60 per lineal foot. Based on these values, the total net cost for the R-20 roof deck insulation is about $720.

The construction costs in Climate Zone 5 are higher – about $1,013 more due to the higher insulation requirements. The proposed insulating value in this colder climate zone is R-25 or R-15 (air impermeable) + R-20 (air impermeable). In addition, the gable end walls receive R-19 to comply with the prescriptive value for the climate zone.

Table 6: Costs and Savings of Installing R-20 Spray Foam Roof Insulation

	# Units	Unit Cost	Total
Eliminate R-30 Attic Floor Insulation (sq ft)	1,475	-$0.55	-$811.25
Eliminate Insulated Attic Stairs (#)	1	-20	-20.00
Eliminate Attic Ridge Vent and Soffit Vents (#)	3	-120	-360.00
R-6 ductwork instead of R-8 (sq ft)	426	-0.115	-49.00
Cost of air sealing drywall to top plate joints (lin ft)	450	-0.6	-270.00
Add R-20 Foam Roof Deck Insulation (sq ft)	1,717	1.1	1,888.70
Add R-15 Gable End Wall Insulation (sq ft)	378	0.9	340.20
Net Cost Difference			**$718.65**

6. Cost Analysis Summary

Table 7 summarizes the cost analysis for the R-20 roof deck option. The annual energy savings exceed the additional mortgage costs for the home. The simple payback is 8.1 to 8.8 years, but the payback period for the additional down payment is only 2.6 to 2.9 years, which reflects the cash flow that the homeowner will actually experience. The annual rate of return ranges from 29% to about 37%, which is tax-free.

Table 7: Economic Analysis of Installing Foam Roof Deck Insulation

	Climate Zone 3	**Climate Zone 4**	**Climate Zone 5**
Construction Cost for Roof Deck Insulation	$719	$719	$894
Annual Energy Savings	$82	$83	$110
Simple Payback Period (Yrs)	**8.8**	**8.7**	**8.1**
Construction Cost for Roof Deck Insulation	$719	$719	$894
Downpayment in Mortgage (20% assumed)	$144	$144	$179
Additional Annual Mortgage Costs (4% loan for 30 years)	$33	$33	$41
Annual Energy Savings	$82	$83	$110
Net Annual Savings (Annual Energy Savings - Annual Mortgage Costs)	**$49**	**$50**	**$69**
Years to Pay Back Downpayment (Downpayment / Net Annual Savings)	**2.9**	**2.9**	**2.6**
Annual Rate of Return on Financed Investment	36.6%	30.2%	29.0%

7. Additional Benefits

There are additional advantages to insulating under or above the roof deck, including:

- Less cumbersome installation of ductwork, as some of the ducts and air flow boxes can rest on structural elements of the ceiling rather than having to hang from the rafters.
- Non-degradation of insulation over time, as the insulation is not in the way of renovation activities, service contractors, rodents, or attic storage.
- Reduced summer and winter peak demands.
- Improved comfort due to lower attic temperatures in summer and warmer temperatures in winter.
- Air delivered through attic ductwork will not warm as much in summer or cool as much in winter .
- Attic space is more usable.
- Elimination of moisture migration through ridge and soffit vents.

8. Consideration that the Proposed Amendment Applies only to Section 406

Of course, the proposed amendment only applies to the Energy Rating Index (ERI) Compliance Alternative in Section 406 of the Energy Conservation Code. The ERI is a relative indicator of efficiency, whereby a score of 100 indicates a home in compliance with the 2006 International Energy Conservation Code. Homes that

comply with the prescriptive values for the 2018 North Carolina Energy Conservation Code typically achieve an ERI of about 75 in Climate Zone 3 and 80 in Climate Zones 4 and 5, which means they experience about 75% to 80% of the energy consumption of a home with an ERI of 100. Thus, the lower the ERI, the more efficient the home.

To meet the requirements of Section 406, where the amendment applies, the homes would have to meet the following ERI values, which would require substantial added investment in efficiency and would save a significant amount of energy each year – typically several hundred dollars in annual savings:

Climate Zone 3:	65 (until Dec. 31, 2022)	61 (after Dec. 31, 2022)
Climate Zone 4:	67 (until Dec. 31, 2022)	63 (after Dec. 31, 2022)
Climate Zone 5:	67 (until Dec. 31, 2022)	63 (after Dec. 31, 2022)

As an example, given that the house meets the conditions in this example, the following measures would provide an ERI of 63 in Climate Zone 4:

- Higher efficiency windows (from U-0.35 to U-0.29; SHGC from 0.30 to 0.25)
- R-5 sheathing on exterior walls
- 100% High efficacy lighting
- Heat pump water heater (from EF 0.91 to 2.4)
- High efficiency heating and cooling (from SEER 14 to SEER 18; from HSPF 8.2 to HSPF 10)

The energy savings from the above features would approximate $500 per year – a 25% reduction in the homes' energy bills. Thus, builders wishing to pursue the ERI route to utilize the allowance for R-20 roof deck insulation would provide hundreds of dollars of additional annual savings to their customers.

Alternatives

1) Leaving the NCECC unchanged. Not changing the code will disallow the use of spray foam overhead in an attic as spray foam cannot achieve the current required R-value except when applied to the attic floor. Applying it to an attic floor basically removes the attic from any type of storage use because the floor cannot be covered with wood because the foam will be thicker than the required ceiling joists. That will result in the use of the less expensive batt or blown insulation that most of us are familiar with.
2) Reducing the R-value for spray foam below the proposed values. The values chosen are based on it providing a near equivalent energy conservation to the current code requirement. A reduction to a lower R-value would extend the payback time (assuming air leakage affects the energy efficiency) or negate it entirely because there would be greater energy consumption. The lower R-value allows more heating or cooling to be lost through the roof construction, and there is no intent of the proposed amendment to allow an increase in energy consumption through these amendments.
3) Increasing the R-values for spray foam above the proposed values. Spray foam is limited in the R-value that it can provide and can provide in a cost-effective manner for overhead installations. Spray foam can only resist a limited amount of weight because the adhesive quality of the product limits its adhesion to the underside of the roof deck and rafters. Additional foam adds additional weight. The added weight then may cause the foam to separate from the roof decking and fall away. Also, like any other insulation, greater thickness yields less energy loss, but there is a point where that loss is negligible.

Summary

The Building Code Council has received petitions to reduce the R-value (insulation value) for spay foam insulation installed on attic ceilings and walls from R-38 to R-20 when builders choose to use the ERI method of compliance. This code amendment would make spray foam relatively more cost competitive to install because of the expected long term payback in reduced energy consumption. This petition is based on the concept that spray foam is inherently installed such that it allows less leakage of conditioned air out of the dwelling than other insulation types and thus improves energy efficiency.

Opponents of this proposed amendment contend that air leakage should not be considered when determining the financial cost/benefit. Opponents believe that the openings in an attic floor and ductwork in the attic must also meet the same air leakage requirements as provided by spray foam insulation applied to the underside of the roof sheathing and attic walls. The position of the council is that spray foam will overcome installation errors that typically occur with ductwork and attic floor installed insulation as well as maintain an improved reduced air leakage rate over time because of the durability of spray foam. The durability is accomplished because it is not located on the floor of the attic and because adhesion of the material to the building structure and appurtenances is not affected by changing temperatures and humidity.

The expected economic impact depends upon key modeling assumptions. If a dwelling is constructed using spray foam applied to the roof decking and if the spray foam reduces air leakage, the analysis indicates that it will first incur net costs but then realize cost savings in 2.9 to 8.8 years for Climate Zone 3, 2.9 to 8.7 years for Climate Zone 4, and 2.6 to 8.1 years for Climate Zone 5 as the cumulative annual energy savings exceed initial construction costs (see Table 7). Alternatively, if the spray foam does not reduce the air leakage then a dwelling will experience growing net costs over time compared to the current Codes.

Based on the following factors, it appears to be appropriate to consider air leakage for spray foam sealed attics using the ERI method:

- The logic that spray foam conforms and seals against objects such as roof penetrations when installed, containing the attic within the home's conditioned space,
- BCC staff's experience that attic floor penetrations can negatively affect the installation and efficacy of floor insulation in unsealed attics, and
- The limited field study provided in Table 2 that detected differences in air and duct leakage between sealed and unsealed attics.

However, the expected cost savings would only be achieved if the ductwork is in the attic. Approximately 60% of new homes in North Carolina have ductwork in the attic (see Table 1). Because spray foam costs more to initially install it is unlikely that the material will be used unless the heating/cooling ductwork is installed in the attic. Ducts are typically installed in an attic if the house is 2-story or if the house is constructed with a concrete slab on grade. Because there are three methods of energy conservation compliance and the use of spray foam for the ERI method is an option it is difficult to estimate how many dwellings will utilize the proposed rule amendment, but it will likely be less than 60%. If ductwork is not located in the attic, the home with R-20 roof deck insulation would have slightly higher energy usage. In addition, there is some uncertainty in the degree of air and duct leakage difference between sealed and unsealed attics and cost savings vary based on modeling assumptions.

Item B – 15 Request from Robert Privott representing N.C. Home Builders Association and Jeff Tiller to amend the 2018 Energy Code, Section R406.2 as follows:

R406.2 Mandatory requirements.

Compliance with this section requires that the provisions identified in Sections R401 through R404 labeled as "mandatory" be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in Table R406.2.1 or Table R406.2.2. ~~Table 402.1.1 or 402.1.3 of the 2012 North Carolina Energy Conservation Code.~~ Minimum standards associated with compliance shall be the ANSI RESNET ICC Standard 301-2014: "Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index." A North Carolina *registered design professional* or certified *HERS rater* is required to perform the analysis if required by North Carolina Licensure laws.

Exception: Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

TABLE R406.2.1
MINIMUM INSULATION AND FENESTRATION REQUIREMENTS FOR ENERGY RATING INDEX COMPLIANCE[a]

	FENESTRATION VALUES			R-VALUES FOR								
CLIMATE ZONE	FENESTRATION U-FACTOR[b,j]	SKYLIGHT[b] U-FACTOR	GLAZED FENSTRATION SHGC[b,k]	CEILING[m]	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMIABLE/ IMPERMEABLE	WOOD FRAME WALL	MASS WALL[l]	FLOOR	BASEMENT[c,o] WALL	SLAB[d]	CRAWL SPACE[c] WALL
3	0.35	0.65	0.3	30	20	15-10[q]	13	5/10	19	10/13[f]	0	5/13
4	0.35	0.6	0.3	38 or 30ci[l]	20	15-10[q]	15, 13+2.5[h]	5/10	19	10/13	10	10/13
5	0.35	0.6	NR	38 or 30ci[l]	25	15-20[q]	19[n], 13+5[h], or 15+3[h]	13/17	30[g]	10/13	10	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums.

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

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

d. For monolithic slabs, insulation shall be applied from the inspection gap downward to the bottom of the footing or a maximum of 18 inches below grade whichever is less. For floating slabs, insulation shall extend to the bottom of the foundation wall or 24 inches, whichever is less. (See Appendix R2) R-5 shall be added to the required slab edge *R*-values for heated slabs.

e. Deleted.

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. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

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

j. In addition to the exemption in R402.3.3, a maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

k. In addition to the exemption in R402.3.3, a maximum of two glazed fenestration product assemblies having a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

l. R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise, R-38 insulation is required where adequate clearance exists or insulation must extend either to the insulation baffle or within 1" of the attic roof deck.

m. Table value required except for roof edge where the space is limited by the pitch of the roof; there the insulation must fill the space up to the air baffle.

n. R -19 fiberglass batts compressed and installed in a nominal 2 × 6 framing cavity is deemed to comply. Fiberglass batts rated R-19 or higher compressed and installed in a 2x4 wall ~~is~~ are not deemed to comply.

o. Basement wall meeting the minimum mass wall specific heat content requirement may use the mass wall R-value as the minimum requirement.

p. The air-impermeable insulation shall meet the requirements of the definition in Section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. For Residential Buildings other than one- and two-family dwellings and townhouses, the insulation installation shall meet the installation requirements of 1203.3 of the North Carolina Building Code. Exposed rafters shall be covered with R-7 insulation.

q. The value for air-permeable insulation is shown first and that for air-impermeable insulation second. Thus, R-15 + R-10 indicates that the minimum value for air-permeable insulation is R-15, and the minimum value for air-impermeable insulation is R-10. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. The air-permeable insulation shall be installed directly under the air-impermeable insulation. Exposed rafters shall be covered with R-7 insulation.

TABLE R406.2.2
EQUIVALENT U-FACTORS FOR TABLE R406.2.1

CLIMATE ZONE	FENESTRATION [d]	SKYLIGHT	CEILING	UNVENTED [e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED [e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMEABLE/ IMPERMEABLE	FRAME WALL	MASS WALL [b]	FLOOR	BASEMENT [d] WALL	CRAWL SPACE [c] WALL
3	0.35	0.65	0.0350	0.05	0.043[f]	0.082	0.141	0.047	0.059	0.136
4	0.35	0.60	0.0300	0.05	0.043[f]	0.077	0.141	0.047	0.059	0.065
5	0.35	0.60	0.0300	0.037	0.034[f]	0.061	0.082	0.033	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 0.07 in Climate Zone 3, 0.07 in Climate Zone 4 and 0.054 in Climate Zone 5.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure R301.1 and Table R301.1.

d. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty. When applying this note and using the REScheck "UA Trade-off" compliance method to allow continued use of the software, the applicable fenestration products shall be modeled as meeting the U-factor of 0.35 and the SHGC of 0.30, as applicable, but the fenestration products' actual U-factor and actual SHGC shall be noted in the comments section of the software for documentation of application of this note to the applicable products. Compliance for these substitute products shall be verified compared to the allowed substituted maximum U-value requirement and maximum SHGC requirement, as applicable.

e. The air-impermeable insulation shall meet the requirements of the definition in section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. Exposed rafters shall be covered with R-7 insulation.

f. For air-permeable/ impermeable applications, Table R406.2.1 shall be followed for minimum insulation values.

Robert Privott spoke as the proponent for this item as well as item B-21.

Residential Super Committee: Motion to grant made by D. Smith. Second by D. Shearin.
Motion passed with three in support and two against.

Commercial Super Committee: Motion to grant made by V. Watlington. Second by R. Davis.
Motion passed with five in support and four against.

Building Code Council: Motion to grant made by R. Euchner. Second by F. Meads.
Motion passed with five against.

Item B – 21 Request from Robert Privott representing N.C. Home Builders Association and Jeff Tiller to amend the 2018 N.C. Energy Code, Section N1106.2 Mandatory Requirements as follows:

N1106.2 Mandatory requirements.

Compliance with this section requires that the provisions identified in Sections N1101 through N1104 labeled as "mandatory" be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in Table N1106.2.1 or Table N1106.2.2. ~~Table 402.2.3 or 402.1.3 of the 2012 North Carolina Energy Conservation Code.~~ Minimum standards associated with compliance shall be the ANSI RESNET ICC Standard 301-2014: "Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an

Energy Rating Index." A North Carolina *registered design professional* or certified *HERS rater* is required to perform the analysis if required by North Carolina Licensure laws.

Exception: Supply and return ducts in unconditioned space and outdoors shall be insulated to a minimum R-8. Supply ducts inside semi-conditioned space shall be insulated to a minimum R-4; return ducts inside conditioned and semi-conditioned space are not required to be insulated. Ducts located inside conditioned space are not

required to be insulated other than as may be necessary for preventing the formation of condensation on the exterior of cooling ducts.

TABLE N1106.2.1
MINIMUM INSULATION AND FENESTRATION REQUIREMENTS FOR ENERGY RATING INDEX COMPLIANCE[a]

	FENESTRATION VALUES			R-VALUES FOR								
CLIMATE ZONE	FENESTRATION U-FACTOR[b,j]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC[b,k]	CEILING[m]	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED[p] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMIABLE/ IMPERMEABLE	WOOD FRAME WALL	MASS WALL[l]	FLOOR	BASEMENT[c,o] WALL	SLAB[d]	CRAWL SPACE[c] WALL
3	0.35	0.65	0.3	30	20	15-10[q]	13	5/10	19	10/13[f]	0	5/13
4	0.35	0.6	0.3	38 or 30ci[l]	20	15-10[q]	15, 13+2.5[h]	5/10	19	10/13	10	10/13
5	0.35	0.6	NR	38 or 30ci[l]	25	15-20[q]	19[n], 13+5[h], or 15+3[h]	13/17	30[g]	10/13	10	10/13

For SI: 1 foot = 304.8 mm.

a. *R*-values are minimums. *U*-factors and SHGC are maximums.

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

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

d. For monolithic slabs, insulation shall be applied from the inspection gap downward to the bottom of the footing or a maximum of 18 inches below grade whichever is less. For floating slabs, insulation shall extend to the bottom of the foundation wall or 24 inches, whichever is less. (See Appendix O) R-5 shall be added to the required slab edge *R*-values for heated slabs.

e. Deleted.

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

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. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2.

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

j. In addition to the exemption in N1102.3.3, a maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

k. In addition to the exemption in N1102.3.3, a maximum of two glazed fenestration product assemblies having a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

l. R-30 shall be deemed to satisfy the ceiling insulation requirement wherever the full height of uncompressed R-30 insulation extends over the wall top plate at the eaves. Otherwise, R-38 insulation is required where adequate clearance exists or insulation must extend either to the insulation baffle or within 1" of the attic roof deck.

m. Table value required except for roof edge where the space is limited by the pitch of the roof; there the insulation must fill the space up to the air baffle.

n. R -19 fiberglass batts compressed and installed in a nominal 2 × 6 framing cavity is deemed to comply. Fiberglass batts rated R-19 or higher compressed and installed in a 2x4 wall is are not deemed to comply.

o. Basement wall meeting the minimum mass wall specific heat content requirement may use the mass wall R-value as the minimum requirement.

p. The air-impermeable insulation shall meet the requirements of the definition in Section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. For Residential Buildings other than one- and two-family

dwellings and townhouses, the insulation installation shall meet the installation requirements of 1203.3 of the North Carolina Building Code. Exposed rafters shall be covered with R-7 insulation.

g. The value for air-permeable insulation is shown first and that for air-impermeable insulation second. Thus, R-15 + R-10 indicates that the minimum value for air-permeable insulation is R-15, and the minimum value for air-impermeable insulation is R-10. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. The air-permeable insulation shall be installed directly under the air-impermeable insulation. Exposed rafters shall be covered with R-7 insulation.

TABLE N1106.2.2
EQUIVALENT U-FACTORS FOR TABLE N1106.2.1[a]

CLIMATE ZONE	FENESTRATION[d]	SKYLIGHT	CEILING	UNVENTED[e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-IMPERMEABLE	UNVENTED[e] RAFTER ASSEMBLIES IN ATTICS CONTAINING DUCTWORK, AIR-PERMIABLE/ IMPERMEABLE	FRAME WALL	MASS WALL[b]	FLOOR	BASEMENT[d] WALL	CRAWL SPACE[c] WALL
3	0.35	0.65	0.0350	0.05	0.043[f]	0.082	0.141	0.047	0.059	0.136
4	0.35	0.60	0.0300	0.05	0.043[f]	0.077	0.141	0.047	0.059	0.065
5	0.35	0.60	0.0300	0.037	0.034[f]	0.061	0.082	0.033	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 0.07 in Climate Zone 3, 0.07 in Climate Zone 4 and 0.054 in Climate Zone 5.

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

d. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty. When applying this note and using the RESCheck "UA Trade-off" compliance method to allow continued use of the software, the applicable fenestration products shall be modeled as meeting the U-factor of 0.35 and the SHGC of 0.30, as applicable, but the fenestration products' actual U-factor and actual SHGC shall be noted in the comments section of the software for documentation of application of this note to the applicable products. Compliance for these substitute products shall be verified compared to the allowed substituted maximum U-value requirement and maximum SHGC requirement, as applicable.

e. The air-impermeable insulation shall meet the requirements of the definition in section R202. Air-impermeable insulation shall be installed in direct contact with the underside of the structural roof sheathing. For one- and two-family dwellings and townhouses, the insulation installation shall meet the requirements of R806.5 of the North Carolina Residential Code. Exposed rafters shall be covered with R-7 insulation.

f. For air-permeable/ impermeable applications, Table N1106.2.1 shall be followed for minimum insulation values.

Robert Privott spoke on this item as the proponent.

Residential Super Committee: Motion to grant made by D. Smith. Second by D. Shearin.
Motion passed.

Building Code Council: Motion to grant made by R. Euchner. Second by F. Meads.
Motion passed with four in opposition.