APPENDIX 4

ADDITIONAL VOLUNTARY CRITERIA FOR INCREASING ENERGY EFFICIENCY (High Efficiency Residential Option)

1. **Introduction.** The increased energy efficiency measures identified in this appendix are strictly voluntary at the option of the permit holder and have been evaluated to be the most cost effective measures for achieving an additional 15-20% energy efficiency beyond the code minimums.
2. **Requirements.** Follow all sections of the Chapter 4 of the *North Carolina Energy Conservation Code*, except the following.

   a. Instead of using Table 402.1.1 in Section 402.1.1, use Table 4A shown below.

TABLE 4A
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[k]	WOOD FRAME WALL *R*-VALUE[e]	MASS WALL *R*-VALUE[i]	FLOOR *R*-VALUE	BASEMENT[c] WALL *R*-VALUE	SLAB[d] *R*-VALUE	CRAWL SPACE[c] WALL *R*-VALUE
3	0.32[j]	0.65	0.25	38	19, 13+5, or 15+3[e,h]	5/10	19	10/13[f]	5	10/13
4	0.32	0.60	0.25	38	19, 13+5, or 15+3[e,h]	5/10	19	10/13	10	10/13
5	0.32	0.60	(NR)	38	19, 13+5, or 15+3[e,h]	13/17	30[g]	10/13	10	15/19

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. 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 2 × 4 wall is not deemed to comply.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.2 and Tables 301.1 and 301.3.

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

h. "13+5" means R-13 cavity insulation plus R-5 insulated sheathing. 15+3 means R-15 cavity insulation plus R-3 insulated sheathing. 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. 13+2.5 means R-13 cavity insulation plus R-2.5 sheathing.

i. For Mass Walls, the second R-value applies when more than half the insulation is on the interior of the mass wall.

j. 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 to either the insulation baffle or within 1" of the attic roof deck.

k. 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.

   b. Instead of using Table 402.1.3 in Section 402.1.3, use Table 4B to find the maximum *U*-factors for building components.

TABLE 4B
EQUIVALENT U-FACTORS[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR	SKYLIGHT *U*-FACTOR	CEILING *U*-FACTOR	FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR[d]	CRAWL SPACE WALL *U*-FACTOR[c]
3	0.32	0.65	0.030	0.061	0.141	0.047	0.059	0.065
4	0.32	0.60	0.030	0.061	0.141	0.047	0.059	0.065
5	0.32	0.60	0.030	0.061	0.082	0.033	0.059	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 0.12 in Zone 3, 0.10 in Zone 4, and the same as the frame wall *U*-factor in Zone 5.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Table 301.1 and Figure 301.2.

d. Foundation *U*-factor requirements shown in Table 4B include wall construction and interior air films but exclude soil conductivity and exterior air films. *U*-factors for determining code compliance in accordance with Section 402.1.4 (total UA alternative) shall be modified to include soil conductivity and exterior air films.

   c. Instead of using the air leakage value for maximum leakage shown in Section 402.4.2.2, use the following:

      i. 0.24 CFM50/Square Foot of Surface Area (SFSA) or

ii. Four (4) air changes per hour (ACH50)

d. Instead of using the duct leakage value for maximum leakage shown in Section 403.2.2, use the following:

Total duct leakage less than or equal to 4 CFM (12 L/min) per 100 ft2 (9.29 m^2) of *conditioned floor area* served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across

Table 4C
Sample Confirmation Form for
ADDITIONAL VOLUNTARY CRITERIA FOR INCREASING ENERGY EFFICIENCY
(High Efficiency Residential Option)

NORTH CAROLINA ENERGY CONSERVATION CODE: HIGH EFFICIENCY RESIDENTIAL OPTION INSULATION AND FENESTRATION VALUES				PROPOSED PROJECT VALUES
Climate Zone	**3**	**4**	**5**	
Fenestration *U*-Factor	0.32[j]	0.32[j]	0.32[j]	
Skylight *U*-Factor	0.65	0.6	0.6	
Glazed Fenestration SHGC[b, e]	0.25	0.25	NR	
Ceiling *R*-value	38	38	38	
Wood Frame Wall *R*-value[e]	19, 13+5, or 15+3[eh]	19, 13+5, or 15+3[eh]	19, 13+5, or 15+3[eh]	
Mass Wall *R*-value[j]	5/10	5/10	13/17	
Floor *R*-value	19	19	30[g]	
Basement Wall *R*-value[c]	10/13[f]	10/13[f]	10/13[f]	
Slab *R*-value and Depth[d]	5, 2 ft	10, 2 ft	10, 2 ft	
Crawl Space Wall *R*-value[c]	10/13	10/13	15/19	
Building Air Leakage				
Visually inspected according to N1102.4.2.1 (check box) OR				
Building Air Leakage Test according to N1102.4.2.2 (check box). Show test value:				
ACH50 [Target: 4.0], or				
CFM50/SFSA [Target: 0.24]				
Name of Tester / Company:				
Date:				
Duct Insulation and Sealing				
Insulation Value	R-			
Duct Leakage Test Result (Sect. N1103.2.2)				
(CFM25 Total/100SF) [Target:4]				
Name of Tester or Company:				
Date:				

4D:
SAMPLE WORKSHEETS FOR RESIDENTIAL AIR AND DUCT LEAKAGE TESTING
4D.1
Air sealing: Visual inspection option (Section 402.4.2.1)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section 402.4.2.1 or 402.4.2.2:

402.4.2.1 Visual inspection option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section 402.2.12 and air sealing in Section 402.4.1 are addressed and when the items listed in Table 402.4.2, applicable to the method of construction, are certified by the builder, permit holder or registered design professional via the certificate in Appendix 1.1.

TABLE 402.4.2
AIR BARRIER INSPECTION

COMPONENT	CRITERIA
Ceiling/attic	Sealants or gaskets provide a continuous air barrier system joining the top plate of framed walls with either the ceiling drywall or the top edge of wall drywall to prevent air leakage. Top plate penetrations are sealed. For ceiling finishes that are not air barrier systems such as tongue-and-groove planks, air barrier systems; (for example, taped house wrap), shall be used above the finish. **Note:** It is acceptable that sealants or gaskets applied as part of the application of the drywall will not be observable by the code official
Walls	Sill plate is gasketed or sealed to subfloor or slab.
Windows and doors	Space between window and exterior door jambs and framing is sealed.
Floors (including above-garage and cantilevered floors)	Air barrier system is installed at any exposed edge of insulation.
Penetrations	Utility penetrations through the building thermal envelope, including those for plumbing, electrical wiring, ductwork, security and fire alarm wiring, and control wiring, shall be sealed.
Garage separation	Air sealing is provided between the garage and conditioned spaces. An air barrier system shall be installed between the ceiling system above the garage and the ceiling system of interior spaces.
Duct boots	Sealing HVAC register boots and return boxes to subfloor or drywall.
Recessed lighting	Recessed light fixtures are air tight, IC rated, and sealed to drywall. **Exception**—fixtures not penetrating the building envelope.

Property Address:

_____

402.4.2.1 Visual inspection option

The inspection information including tester name, date, and contact shall be included on the certificate described in Section 401.3.

_____ _____

Signature Date

4D.2
Air sealing: Testing option (Section 402.4.2.2)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section 402.4.2.1 or 402.4.2.2:

402.4.2.2 Testing option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in Section 402.2.12 and air sealing in Section 402.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.24 CFM50/Square Foot of Surface Area (SFSA) or

2. Four (4) air changes per hour (ACH50)

When tested with a blower door fan assembly, at a pressure of 33.5 psf (50 Pa). A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the blower door fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E 779-03. Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances. Testing shall be reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, *a certified BPI Envelope Professional or a certified HERS rater.*

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed;
2. Dampers shall be closed, but not sealed, including exhaust, backdraft, and flue dampers;
3. Interior doors shall be open;
4. Exterior openings for continuous ventilation systems, air intake ducted to the return side of the conditioning system, and energy or heat recovery ventilators shall be closed and sealed;
5. Heating and cooling system(s) shall be turned off; and
6. Supply and return registers shall not be sealed.

The air leakage information, including building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section 401.3.

For Test Criteria 1 above, the report shall be produced in the following manner: Perform the blower door test and record the *CFM50*_____. Calculate the total square feet of surface area for the building thermal envelope, all floors, ceilings, and walls (this includes windows and doors) and record the area_____. Divide *CFM50* by the total square feet and record the result below. If the result is less than or equal to **[0.30 CFM50/SFSA]** the envelope tightness is acceptable; or

For Test Criteria 2 above, the report shall be produced in the following manner: Perform a blower door test and record the *CFM50*_____. Multiply the CFM50 by 60 minutes to create CFHour50 and record _____. Then calculate the total conditioned volume of the home and record_____. Divide the CFH50 by the total volume and record the result below. If the result is less than or equal to **[5 ACH50]** the envelope tightness is acceptable.

Property Address: _____

Fan attachment location: _____Company Name: _____

Contact Information: _____

_____ _____
Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor, NC Licensed Home Inspector, Registered Design Professional, Certified BPI Envelope Professional, or Certified HERS Rater

(circle one)

4D.3
Duct sealing. Duct air leakage test (Section 403.2.2)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

403.2.2 Sealing. All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Part V – Mechanical, Section 603.9 of the *North Carolina Residential Code*.

Duct tightness shall be verified as follows:

Total duct leakage less than or equal to 4 CFM (12 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floor area* served by that system when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct connected to the conditioning system.
2. The duct air leakage testing equipment shall be attached to the largest return in the system or to the air handler.
3. The filter shall be removed and the air handler power shall be turned off.
4. Supply boots or registers and return boxes or grilles shall be taped, plugged, or otherwise sealed air tight.
5. The hose for measuring the 25 Pascals of pressure differential shall be inserted into the boot of the supply that is nominally closest to the air handler.
6. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage.

Testing shall be performed and reported by the permit holder, a NC licensed general contractor, a NC licensed HVAC contractor, a NC licensed Home Inspector, a registered design professional, a certified BPI Envelope Professional or a certified HERS rater. A single point depressurization, not temperature corrected, test is sufficient to comply with this provision, provided that the duct testing fan assembly has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E 1554-07.

The duct leakage information, including duct leakage result, tester name, date, company and contact information, shall be included on the certificate described in Section 401.3.

For the Test Criteria, the report shall be produced in the following manner: perform the HVAC system air leakage test and record the CFM25. Calculate the total square feet of Conditioned Floor Area (CFA) served by that system. Multiply CFM25 by 100, divide the result by the CFA and record the result. If the result is less than or equal to **[4 CFM25/100 SF]** the HVAC system air tightness is acceptable.

Complete one duct leakage report for each HVAC system serving the home:

Property Address: _____

HVAC System Number: _____ Describe area of home served: _____

CFM25 Total _____. Conditioned Floor Area (CFA) served by system: _____ s.f.

CFM25 x 100 divided by CFA = _____ CFM25/100SF (e.g. 100 CFM25 x 100/2,000 CFA = 5 CFM25/100SF)

Fan attachment location: _____

Company Name: _____

Contact Information: _____

_____ _____
Signature of Tester Date

Permit Holder, NC Licensed General Contractor, NC Licensed HVAC Contractor, NC Licensed Home Inspector, Registered Design Professional, Certified BPI Envelope Professional, or Certified HERS Rater

(circle one)