the wall top plate at the eaves. ~~Similarly, where Section R402.1.2 would require R-49 insulation in the ceiling, installing R-38 over 100 percent of the ceiling area requiring insulation shall be deemed to satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves.~~ 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.

Exceptions:

1) When insulation is installed in a fully *enclosed attic floor system*, as described in Appendix 1.2.1, R-30 shall be deemed compliant.

2. In roof edge and other details such as bay windows, dormers, and similar areas where the space is limited, the insulation must fill the space up to the air baffle.

R402.2.2 Ceilings without attic spaces.

Where Section R402.1.2 would require R-38 insulation ~~levels above R-30~~ and the design of the roof/ceiling assembly, including cathedral ceilings, bay windows and other similar areas, does not allow sufficient space for the required insulation, the minimum required insulation for such roof/ceiling assemblies shall be R-30. 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.

R402.2.3 Soffit ~~Eave~~ baffle.

For air-permeable insulations in vented attics, a baffle shall be installed adjacent to soffit ~~and eave~~ vents. ~~Baffles shall maintain an opening equal or greater than the size of the vent.~~ The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material.

R402.2.4 Access hatches and doors.

Horizontal access hatches ~~doors~~ from conditioned spaces to *unconditioned space*s such as attics and crawl spaces shall be weatherstripped and insulated to an R-10 minimum value ~~a level equivalent to the insulation on the surrounding surfaces~~ and vertical doors to such spaces shall be weatherstripped and insulated to R-5. 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.

Exception:

1. Full size vertical doors that provide access from conditioned to *unconditioned space*s shall be permitted to meet the fenestration requirements of Table R402.1.2 based on the applicable climate zone specified in Chapter 3.
2. Pull down stair systems shall be weatherstripped and insulated to a minimum R-5 insulation value such that the insulation does not interfere with proper operation of the stair. Non-rigid insulation materials are not allowed. Additional insulation systems that enclose the stair system from above are allowed. Exposed foam plastic must meet the provisions of the Building Code or Residential Code, respectively.

R402.2.5 Mass walls.

Mass walls for the purposes of this chapter shall be considered ~~above-grade~~ walls of concrete block, concrete, insulated concrete form (ICF), masonry cavity, brick (other than brick veneer), earth (adobe, compressed earth block, rammed earth) and solid timber/logs, or any other walls meeting the specification immediately following. ~~having a heat capacity greater than or equal to 6 Btu/ft² × °F (123 kJ/m² × K).~~ Masonry or concrete walls having a mass greater than or equal to 30 pounds per square foot (146 kg/m²). Solid wood walls having a mass greater than 20 pounds per square foot (98 kg/m²), and any ~~other~~ walls having a heat capacity greater than or equal to 6 Btu/ft² *°F[266 J/(m²*K)]

R402.2.6 Steel-frame ceilings, walls and floors.

Steel-frame ceilings, walls, and floors shall meet the insulation requirements of Table R402.2.6 or shall meet the *U*-factor requirements of Table R402.1.4. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

TABLE R402.2.6
STEEL-FRAME CEILING, WALL AND FLOOR INSULATION
(R-VALUE)

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL EQUIVALENT *R*-VALUE[a]
Steel Truss Ceilings[b]	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
Steel Joist Ceilings[b]	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-Framed Wall, 16" on center	
R-13	R-13 + 4.2 or R-19 + 2.1 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1
R-13 + 3	R-0 + 11.2 or R-13 + 6.1 or R-15 + 5.7 or R-19 + 5.0 or R-21 + 4.7
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-19 + 6.2 or R-21 + 7.5
R-20 + 5	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
Steel Framed Wall, 24" on center	
R-13	R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4
R-13 + 3	R-0 + 11.2 or R-13 + 4.9 or R-15 + 4.3 or R-19 + 3.5 or R-21 + 3.1
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20 + 5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or

	R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
Steel Joist Floor	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

a Cavity insulation *R*-value is listed first, followed by continuous insulation *R*-value.
b. Insulation exceeding the height of the framing shall cover the framing.

R402.2.7 Walls with partial structural 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. ~~Where Section R402.1.2 would require continuous insulation on exterior walls and structural sheathing covers 40 percent or less of the gross area of all exterior walls, the continuous insulation *R*-value shall be permitted to be reduced by an amount necessary to result in a consistent total sheathing thickness, but not more than R-3, on areas of the walls covered by structural sheathing.~~ 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.

R402.2.8 Floors.
Floor framing-cavity insulation shall be installed to maintain permanent contact with the underside of the subfloor decking. The distance between tension support wires or other devices that hold the floor insulation in place against the subfloor shall be no more than 18 inches. In addition, supports shall be located no further than 6 inches from each end of the insulation.

Exception: ~~The floor framing-cavity insulation shall be permitted to be in contact with the topside of sheathing or continuous insulation installed on the bottom side of floor framing where combined with insulation that meets or exceeds the minimum wood frame wall *R*-value in Table 402.1.2 and that extends from the bottom to the top of all perimeter floor framing members.~~ Enclosed floor cavity such as garage ceilings, cantilevers or buildings on pilings with enclosed floor cavity with the insulation fully in contact with the lower air barrier. In this case, the band boards shall be insulated to maintain thermal envelope continuity.

R402.2.9 Basement walls.
Walls associated with conditioned basements shall be insulated from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less. Walls associated with unconditioned basements shall meet this requirement unless the floor overhead is insulated in accordance with Sections R402.1.2 and R402.2.8. Foam plastic insulation applied to exterior of basement walls shall be provided with termite inspection and treatment gaps in accordance with Appendix 2.

R402.2.10 Slab-on-grade floors.
~~Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.2. The insulation shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.2 by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the~~

~~*exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall.* Slab-edge insulation is not required in jurisdictions designated by the *code official* as having a very heavy termite infestation.~~

Slab-on-grade floors with a floor surface less than 12 inches (305 mm) below grade shall be insulated in accordance with Table R402.1.2. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Slab edge insulation shall have 2" termite inspection gap consistent with Appendix 2 of this code.

R402.2.11 Closed Crawl space walls.

~~As an alternative to insulating floors over crawl spaces, crawl space walls shall be permitted to be insulated when the crawl space is not vented to the outside. Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the floor to the finished grade level and then vertically and/or horizontally for at least an additional 24 inches (610 mm). Exposed earth in unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the *International Building Code* or *International Residential Code*, as applicable. All joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up the stem wall and shall be attached to the stem wall.~~

Where the floor above a closed crawl space is not insulated, the exterior crawlspace walls shall be insulated in accordance with table R402.1.2.

Wall insulation may be located in any combination of the outside and inside wall surfaces and within the structural cavities or materials of the wall system.

Wall insulation requires that the exterior wall band joist area of the floor frame be insulated. Wall insulation shall begin 3 inches (76.2mm) below the top of the masonry foundation wall and shall extend down to 3 inches (76.2mm) above the top of the footing or concrete floor, 3 inches(76.2mm) above the interior ground surface or 24 inches (609.6mm) below the outside finished ground level, whichever is less. (See Appendix 1.2.2 details)

Termite inspection, clearance, and wicking gaps are allowed in wall insulation systems. Insulation may be omitted in the gap area without energy penalty. The allowable insulation gap widths are listed in Table 402.2.11. If gap width exceeds the allowances, one of the following energy compliance options shall be met:

1. Wall insulation is not allowed and the required insulation value shall be provided in the floor system.

2. Compliance shall be demonstrated with energy trade-off methods provided by a North Carolina-specific version of RESCHECK or the UA Alternative method or Section R405.

TABLE R402.2.11
WALL INSULATION ALLOWANCES FOR TERMITE TREATMENT AND INSULATION GAPS

Gap Width (inches)	Insulation Location	Gap Description

Minimum	Maximum		
2	3	Outside	Above grade inspection between top of insulation and bottom of siding
4	6	Outside	Below grade treatment
3[a]	4[a]	Inside	Wall inspection between top of insulation and bottom of sill
3[a]	4[a]	Inside	Clearance / wicking space between bottom of insulation and top of ground surface, footing, or concrete floor

For SI 1 inch = 25.4 mm

a. No insulation shall be required on masonry walls of 9 inches in height or less.

R402.2.12 Masonry veneer.
Insulation shall not be required on the horizontal portion of the foundation that supports a masonry veneer.

R402.2.13 Sunroom insulation.
Sunrooms enclosing conditioned space shall meet the insulation requirements of this code.

Exception: For *sunrooms* with *thermal isolation*, and enclosing conditioned space, the following exceptions to the insulation requirements of this code shall apply:

1. The minimum ceiling insulation *R*-values shall be R-19 in *Climate Zones* 3 ~~1~~ and ~~through~~ 4 and R-24 in *Climate Zone~~s~~* 5 ~~through 8~~.

2. The minimum wall *R*-value shall be R-13 in all *climate zones*. New walls separating a *sunroom* with a *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

402.2.14 Framed cavity walls. The exterior thermal envelope wall insulation shall be installed in contact and continuous alignment with the building envelope air barrier. Insulation shall be free from installation gaps, voids, or compression. For framed walls, the cavity insulation shall be enclosed on all sides with solid rigid material or an air barrier material. Polyethylene shall not be allowed. Rim joists are not required to be enclosed on all sides. Wall insulation shall be enclosed at the following locations when installed on exterior walls prior to being covered by subsequent construction, consistent with the Appendix 1.2.3 of this code:

1. Tubs
2. Showers
3. Stairs
4. Fireplace units (Enclose with rigid material only)

402.2.15 Attic knee walls. Enclosure of wall cavity insulation also applies to walls that adjoin attic spaces by placing a rigid material or air barrier material on the attic space side of the wall on the attic space side of the wall consistent with the Appendix 1.2.3 of this code. Joints shall be air sealed. Non-insulating class I vapor retarders, such as polyethylene, shall not be allowed.

R402.3 Fenestration (Prescriptive).
In addition to the requirements of Section R402, fenestration shall comply with Sections R402.3.1 through R402.3.5.

R402.3.1 *U*-factor.
An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor requirements.

R402.3.2 Glazed fenestration SHGC.
An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.

Dynamic glazing shall be permitted to satisfy the SHGC requirements of Table R402.1.2 provided the ratio of the higher to lower labeled SHGC is greater than or equal to 2.4, and the *dynamic glazing* is automatically controlled to modulate the amount of solar gain into the space in multiple steps. *Dynamic glazing* shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall not be permitted.

Exception: *Dynamic glazing* is not required to comply with this section when both the lower and higher labeled SHGC already comply with the requirements of Table R402.1.2.

R402.3.3 Glazed fenestration exemption.
~~Up to~~ Either two glazed fenestration assemblies or up to 24 ~~15~~ square feet (~~1.4~~ 2.2 m^2) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section R402.1.2. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

R402.3.4 Opaque door ~~exemption~~.
Opaque doors separating conditioned from *unconditioned space* shall have a maximum *U*-factor of 0.35.

Exception: One side-hinged opaque door assembly ~~up to 24 square feet (2.22 m^2) in area~~ is exempted from the *U*-factor requirement in Section R402.1.2 ~~4~~. This exemption shall not apply to the *U*-factor alternative approach in Section R402.1.4 and the total UA alternative in Section R402.1.5.

R402.3.5 Sunroom fenestration. *Sunrooms* enclosing *conditioned space* shall meet the fenestration requirements of this code.

Exceptions:
1. For *sunrooms* with *thermal isolation* and enclosing *conditioned space* in *Climate Zones* 3 ~~2~~ through 5 ~~8~~, the maximum fenestration *U*-factor shall be 0.40 ~~0.45~~ and the

maximum skylight *U*-factor shall be 0.75 ~~0.70~~. Sunrooms with cooling systems shall have a maximum fenestration SHGC of 0.40 for all glazing.

2. A maximum of two glazed fenestration product assemblies having a U-factor no greater than 0.55 and, when cooling is provided, a SHGC no greater than 0.70 shall be permitted to be substituted for minimum code compliant fenestration product assemblies without penalty.

New fenestration separating the *sunroom* with *thermal isolation* from *conditioned space* shall meet the *building thermal envelope* requirements of this code.

~~R402.4 Air leakage (Mandatory).~~

~~The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.5.~~

~~R402.4.1 Building thermal envelope.~~

~~The *building thermal envelope* shall comply with Sections R402.4.1.1 and R402.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction.~~

~~R402.4.1.1 Installation.~~

~~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.~~

~~TABLE R402.4.1.1~~
~~AIR BARRIER AND INSULATION INSTALLATION~~

~~COMPONENT~~	**~~AIR BARRIER CRITERIA~~**	**~~INSULATION INSTALLATION CRITERIA~~**
~~General requirements~~	~~A continuous air barrier shall be installed in the building envelope.~~ ~~The exterior thermal envelope contains a continuous air barrier.~~ ~~Breaks or joints in the air barrier shall be sealed.~~	~~Air-permeable insulation shall not be used as a sealing material.~~
~~Ceiling/attic~~	~~The air barrier in any dropped ceiling/soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed.~~ ~~Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.~~	~~The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.~~
~~Walls~~	~~The junction of the foundation and sill plate shall be sealed.~~	~~Cavities within corners and headers of frame walls shall be insulated by~~

	~~The junction of the top plate and the top of exterior walls shall be sealed.~~ ~~Knee walls shall be sealed.~~	~~completely filling the cavity with a material having a thermal resistance of R-3 per inch minimum.~~ ~~Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.~~
~~Windows, skylights and doors~~	~~The space between window/door jambs and framing, and skylights and framing shall be sealed.~~	
~~Rim joists~~	~~Rim joists shall include the air barrier.~~	~~Rim joists shall be insulated.~~
~~Floors (including above garage and cantilevered floors)~~	~~The air barrier shall be installed at any exposed edge of insulation.~~	~~Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking, or floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extends from the bottom to the top of all perimeter floor framing members.~~
~~Crawl space walls~~	~~Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder with overlapping joints taped.~~	~~Where provided instead of floor insulation, insulation shall be permanently attached to the crawlspace walls.~~
~~Shafts, penetrations~~	~~Duct shafts, utility penetrations, and flue shafts opening to exterior or *unconditioned space* shall be sealed.~~	
~~Narrow cavities~~		~~Batts in narrow cavities shall be cut to fit, or narrow cavities shall be filled by insulation that on installation readily conforms to the available cavity space.~~
~~Garage separation~~	~~Air sealing shall be provided between the garage and conditioned spaces.~~	
~~Recessed lighting~~	~~Recessed light fixtures installed in the building thermal envelope shall be sealed to the drywall.~~	~~Recessed light fixtures installed in the building thermal envelope shall be air tight and IC rated.~~

~~Plumbing and wiring~~		~~Batt insulation shall be cut neatly to fit around wiring and plumbing in exterior walls, or insulation that on installation readily conforms to available space shall extend behind piping and wiring.~~
~~Shower/tub on exterior wall~~	~~The air barrier installed at exterior walls adjacent to showers and tubs shall separate them from the showers and tubs.~~	~~Exterior walls adjacent to showers and tubs shall be insulated.~~
~~Electrical/phone box on exterior walls~~	~~The air barrier shall be installed behind electrical or communication boxes or air-sealed boxes shall be installed.~~	
~~HVAC register boots~~	~~HVAC register boots that penetrate building thermal envelope shall be sealed to the subfloor or drywall.~~	
~~Concealed sprinklers~~	~~When required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.~~	

~~a. In addition, inspection of log walls shall be in accordance with the provisions of ICC-400.~~

~~**R402.4.1.2 Testing.**~~
~~The building or dwelling unit shall be tested and verified as having an air leakage rate not exceeding five air changes per hour in Climate Zones 1 and 2, and three air changes per hour in Climate Zones 3 through 8. Testing shall be conducted in accordance with ASTM E 779 or ASTM E 1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code 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, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.~~

~~2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.~~

~~3. Interior doors, if installed at the time of the test, shall be open.~~

~~4. Exterior doors for continuous ventilation systems and heat recovery ventilators shall be closed and sealed.~~

~~5. Heating and cooling systems, if installed at the time of the test, shall be turned off.~~

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

R402.4 Air leakage control (Mandatory Requirements). The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through R402.4.6.

R402.4.1 Building thermal envelope. The *building thermal envelope* shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. For all homes, where present, the following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, or solid material consistent with Appendix 1.2.4 of this code:

1. Blocking and sealing floor/ceiling systems and under knee walls open to unconditioned or exterior space.
2. Capping and sealing shafts or chases, including flue shafts.
3. Capping and sealing soffit or dropped ceiling areas.
4. Sealing HVAC register boots and return boxes to subfloor or drywall.
5. Seal exterior house wrap material joints and seams per manufacturer's instructions or, if house wrap joints are not sealed, seal exterior sheathing and exposed band joist joints including perimeter joints and edges of these materials.

Exception to item 5:

1. Spray foam in building thermal envelope wall systems.
2. Wall sheathing joints where wall sheathing is fully glued to framing.

R402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by compliance with section R402.4.2.1 or R402.4.2.2. Appendix 3 contains optional sample worksheets for visual inspection or testing for the permit holder's use only.

R402.4.2.1 Visual inspection option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in R402.2.14 and enclosure and air sealing R402.2.15 and air sealing in R402.4.1 are addressed and when the items listed in Table R402.4.2, applicable to the method of construction, are certified by the builder, permit holder or registered design professional via the certificate in Appendix 1.1.

R402.4.2.2 Testing option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in R402.2.14 and enclosure and air sealing R402.2.15 and air sealing in R402.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.30 CFM50/Square Foot of Surface Area (SFSA) or

2. Five (5) 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 E779 or ASTM E 1827. 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 licensed 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, building air leakage result, tester name, date, and contact information, shall be included on the certificate described in Section R401.3.

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 including windows and doors, bounding conditioned space) and record the area. Divide *CFM50* by the total square feet and record the result. 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. If the result is less than or equal to 5 ACH50 the envelope tightness is acceptable.

TABLE R402.4.2
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.
Ceiling penetrations	Ceiling electrical box penetrations and ceiling mechanical box penetrations shall be caulked, gasketed, or sealed at the penetration of the ceiling finish. See Appendix 1.2.4. **Exception**—ceiling electrical boxes and ceiling mechanical boxes not penetrating the building thermal envelope
Recessed lighting	Recessed light fixtures are air tight, IC rated, and sealed to drywall. **Exception**— fixtures in conditioned space.

R402.4.3 ~~2~~ Fireplaces.
~~New wood-burning fireplaces shall have tight-fitting flue dampers or doors, and outdoor combustion air. Where using tight-fitting doors on factory-built fireplaces listed and labeled in accordance with UL 127, the doors shall be tested and listed for the fireplace. Where using tight-fitting doors on masonry fireplaces, the doors shall be listed and labeled in accordance with UL 907.~~
Site-built masonry fireplaces shall have flue dampers and comply with Section R1006 of the *North Carolina Residential Code* for combustion air.

R402.4.4 ~~3~~ Fenestration air leakage.
Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m^2), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m^2), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and *listed* and *labeled* by the manufacturer.

Exception: ~~Field fabricated~~ Site-built windows, skylights and doors.

R402.4.5 ~~4~~ Rooms containing fuel-burning appliances. Deleted. ~~In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel burning appliances, the appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room, isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.2, where the walls, floors and ceilings shall meet not less than the basement wall *R*-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section R403. The combustion air duct shall be insulated where it passes through conditioned space to a minimum of R-8.~~

~~**Exceptions**:~~

1. ~~Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.~~
2. ~~Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the *International Residential Code*.~~

R402.4.6 ~~5~~ Recessed lighting.
Recessed luminaires installed in the *building thermal envelope* shall be sealed to limit air leakage between conditioned and *unconditioned space*s. All recessed luminaires shall be IC-rated and *labeled* as having an air leakage rate not more than 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E 283 at a 1.57 psf (75 Pa) pressure differential. All recessed luminaires shall be sealed with a gasket or caulk between the housing and the interior wall or ceiling covering.

R402.5 Maximum fenestration U-factor and SHGC (Mandatory).
~~The area-weighted average maximum fenestration *U*-factor permitted using tradeoffs from Section R402.1.5 or R405 shall be 0.48 in Climate Zones 4 and 5 and 0.40 in Climate Zones 6 through 8 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section R405 in Climate Zones 1 through 3 shall be 0.50.~~
The area-weighted average maximum fenestration *U*-factor permitted using trade-offs from Section 402.1.5 shall be 0.48. Maximum skylight *U*-factors shall be 0.65 in zones 4 and 5 and 0.60 in zone 3. The area-weighted average maximum fenestration SHGC permitted using trade-offs from Section 405 in zones 3 shall be 0.50.

Exception: 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.

SECTION R403
SYSTEMS

R403.1 Controls (Mandatory).
At least one thermostat shall be provided for each separate heating and cooling system.

R403.1.1 Programmable thermostat.
When the primary heating system is a forced air furnace or heat pump, ~~T~~the thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures down to 55°F (13°C) or up to 85°F (29°C). The thermostat shall initially be programmed by the manufacturer with a heating temperature set point no higher than 70°F (21°C) and a cooling temperature set point no lower than 78°F (26°C).

R403.1.2 Heat pump supplementary heat (Mandatory).
Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

A heat strip outdoor temperature lockout thermostat shall be provided to prevent supplemental heat operation in response to the thermostat being changed to a warmer setting. The lockout shall be set no lower than 35°F and no higher than 40ºF.

Exception:

1. In lieu of a heat strip outdoor temperature lockout thermostat, the following time and temperature electric-resistance control may be used. After six minutes of compressor run time in heat mode, supplemental electric heat shall energize only if the leaving air temperature from the indoor coil is below 90 degrees F. If the indoor coil leaving air temperature exceeds 100 degrees F, supplemental heat shall automatically de-energize, but allow the compressor to continue to operate until the call is satisfied. No thermostat shall initiate supplemental electric heat at any time. Thermostat controlled emergency heat shall not be limited by outdoor temperature. Electric resistance supplemental heat during defrost shall operate normally without limitation.

2. In lieu of a heat strip outdoor temperature lockout thermostat, a programmable indoor thermostat with the capability to minimize the use of supplementary electrical resistance heat using an automatic temperature ramp up control feature shall be acceptable.

R403.2 Hot water boiler outdoor temperature setback.
Hot water boilers that supply heat to the building through one- or two-pipe heating systems shall have an outdoor setback control that lowers the boiler water temperature based on the outdoor temperature.

R403.3 Ducts.
Ducts and air handlers shall be in accordance with Sections R403.3.1 through R403.3.4 ~~5~~.

R403.3.1 Insulation (Mandatory ~~Prescriptive~~).
~~Supply and return ducts in attics shall be insulated to a minimum of R-8 where 3 inches (76 mm) in diameter and greater and R-6 where less than 3 inches (76 mm) in diameter. Supply and return ducts in other portions of the building shall be insulated to a minimum of R-6 where 3 inches (76 mm) in diameter or greater and R-4.2 where less than 3 inches (76 mm) in diameter.~~

~~**Exception:** Ducts or portions thereof located completely inside the *building thermal envelope.*~~

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.

R403.3.2 Sealing (Mandatory).
Ducts, air handlers, ~~and~~ filter boxes, and building cavities used as ducts shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable

Exceptions:

1. Air-impermeable spray foam products shall be permitted to be applied without additional joint seals.

2. ~~For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams, and locking-type joints and seams of other than the snap-lock and button-lock types.~~

~~**R403.3.2.1 Sealed air handler.**~~
~~Air handlers shall have a manufacturer's designation for an air leakage of no more than 2 percent of the design air flow rate when tested in accordance with ASHRAE 193.~~

~~**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*.~~

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

1. ~~Rough-in test: The total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.~~

3. ~~Postconstruction test: Total leakage shall be less than or equal to 4 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.~~

403.3.3 Duct leakage (Prescriptive) and duct testing (Mandatory). Duct testing and duct leakage shall be verified by compliance with either Section 403.3.3.1 or 403.3.3.2. Duct 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(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, 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 5 CFM25/100SF for the “Total duct leakage test or less than or equal to 4 CFM25/100SF for the ‘Duct leakage to the outside” test, then the HVAC system air tightness is acceptable. Appendix 3C contains optional sample worksheets for duct testing for the permit holder’s use only.

Exceptions to testing requirements:

1. Duct systems or portions thereof inside the building thermal envelope shall not be required to be leak tested.

2. Installation of a partial system as part of replacement, renovation or addition does not require a duct leakage test.

403.3.3.1 Total Duct leakage. Total duct leakage less than or equal to 5 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, ventilation air duct(s) 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.

403.3.3.2 Duct Leakage to the Outside. Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be 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, relative to the outside, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) 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 or as tight as possible.
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. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.
7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer's prescribed procedure.
8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:
    a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.
    b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.
    c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.
    d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

R403.3.4 ~~5~~ Building cavities (Mandatory).
Building framing cavities shall not be used as supply ducts or supply plenums.

R403.4 Mechanical system piping insulation (Mandatory).
Mechanical system piping capable of carrying fluids above 105°F (41°C) or below 55°F (13°C) shall be insulated to a minimum of R-3.

~~**R403.4.1 Protection of piping insulation.**~~
~~Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind, and shall provide shielding from solar radiation that can cause degradation of the material. Adhesive tape shall not be permitted.~~

R403.5 Service hot water systems.
~~Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.4.~~ All circulating service hot water piping shall be insulated to at least R-2. Circulating hot water systems shall include an automatic or readily *accessible* manual switch that can turn off the hot water circulating pump when the system is not in use.

~~**R403.5.1 Heated water circulation and temperature maintenance systems (Mandatory).**~~
~~Heated water circulation systems shall be in accordance with Section R403.5.1.1. Heat trace temperature maintenance systems shall be in accordance with Section R403.5.1.2. Automatic controls, temperature sensors, and pumps shall be accessible. Manual controls shall be readily accessible.~~

~~**R403.5.1.1 Circulation systems.**~~
~~Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall start the pump based on the identification of a demand for hot water within the occupancy. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water.~~

~~**R403.5.1.2 Heat trace systems.**~~
~~Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls for such systems shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy.~~

~~**R403.5.2 Demand recirculation systems.**~~
~~A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a cold water supply pipe shall be a *demand recirculation water system*. Pumps shall have controls that comply with both of the following:~~

1. ~~The control shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.~~

2. ~~The control shall limit the temperature of the water entering the cold water piping to 104ºF (40ºC).~~

~~**R403.5.3 Hot water pipe insulation (Prescriptive).**~~
~~Insulation for hot water pipe with a minimum thermal resistance (*R*-value) of R-3 shall be applied to the following:~~

1. ~~Piping $^3/_4$ inch (19.1 mm) and larger in nominal diameter.~~
2. ~~Piping serving more than one dwelling units.~~
3. ~~Piping located outside the conditioned space.~~
4. ~~Piping from the water heater to a distribution manifold.~~
5. ~~Piping located under a floor slab~~.
6. ~~Buried in piping.~~
7. ~~Supply and return piping in recirculation systems other than demand recirculation systems.~~

~~**R403.5.4 Drain water heat recovery units.**~~
~~Drain water heat recovery units shall comply with CSA B55.2. Drain water heat recovery units shall be tested in accordance with CSA B55.1. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi (20.7 kPa) for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi (13.8 kPa) for individual units connected to three or more showers.~~

R403.6 Mechanical ventilation (Mandatory).
The building shall be provided with ventilation that meets the requirements of the *International Residential Code* or *International Mechanical Code*, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

~~**R403.6.1 Whole-house mechanical ventilation system fan efficacy.**~~
~~Mechanical ventilation system fans shall meet the efficacy requirements of Table R403.6.1.~~

~~**Exception:** Where mechanical ventilation fans are integral to tested and listed HVAC equipment, they shall be powered by an electronically commutated motor.~~

~~**TABLE R403.6.1**~~
~~**MECHANICAL VENTILATION SYSTEM FAN EFFICACY**~~

~~FAN LOCATION~~	~~AIR FLOW RATE MINIMUM (CFM)~~	~~MINIMUM EFFICACY (CFM/WATT)~~	~~AIR FLOW RATE MAXIMUM (CFM)~~
~~Range hoods~~	~~Any~~	~~2.8 cfm/watt~~	~~Any~~
~~In-line fan~~	~~Any~~	~~2.8 cfm/watt~~	~~Any~~
~~Bathroom, utility room~~	~~10~~	~~1.4 cfm/watt~~	~~< 90~~
~~Bathroom, utility room~~	~~90~~	~~2.8 cfm/watt~~	~~Any~~

For SI: 1 cfm = 28.3 L/min.

R403.7 Equipment sizing and efficiency rating (Mandatory).
Heating and cooling equipment shall be sized in accordance with the *North Carolina Mechanical Code and/or the NC Residential Code*. New heating and cooling systems shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed~~. Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies. New or replacement heating and cooling equipment shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the equipment is installed.~~

R403.8 Systems serving multiple dwelling units (Mandatory).
Building mechanical systems and service water heating systems serving multiple dwelling units shall comply with Sections C403 and C404 of the IECC—Commercial Provisions in lieu of Section R403.

R403.9 Snow melt and ice system controls (Mandatory).
Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement outdoor temperature is above 50°F (10°C). ~~, and no precipitation is falling and or an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4.8°C).~~

R403.10 Pools and permanent spa energy consumption (Mandatory).
The energy consumption of pools and permanent spas shall be in accordance with Sections R403.10.1 through R403.10.3.

R403.10.1 Heaters.
All heaters shall be equipped with a readily accessible on-off switch that is mounted outside of the heater to allow shutting off the heater without adjusting the thermostat setting. Gas-fired heaters shall not be equipped with constant burning pilot lights. ~~The electric power to heaters shall be controlled by a readily *accessible* on-off switch that is an integral part of the heater mounted on the exterior of the heater, or external to and within 3 feet (914 mm) of the heater. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be equipped with continuously burning ignition pilots.~~

R403.10.2 Time switches.
Time switches or other control methods that can automatically turn off and on according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built-in time switches shall be in compliance with this section.

Exceptions:

1. Where public health standards require 24-hour pump operation.

2. Pumps that operate solar- and waste-heat-recovery pool heating systems.

R403.10.3 Covers.
Outdoor heated pools and outdoor permanent spas shall be provided with a *class 1* *vapor-retardant cover* ~~or other *approved* vapor-retardant means~~.

Exception: Pools deriving over 70% of the energy from heating from *site-recovered energy* or *solar energy source*. ~~Where more than 70 percent of the energy for heating, computed over an operation season, is from site-recovered energy, such as from a heat pump or solar energy source, covers or other vapor-retardant means shall not be required.~~

R403.11 Portable spas (Mandatory).
Deleted. ~~The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.~~

R403.12 Residential pools and permanent residential spas.
Residential swimming pools and permanent residential spas that are accessory to detached one- and two-family dwellings and townhouses three stories or less in height above grade plane and that are available only to the household and its guests shall be in accordance with APSP-15.

SECTION R404
ELECTRICAL POWER AND LIGHTING SYSTEMS

R404.1 Lighting equipment (Mandatory).
Not less than 75 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 75 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

Exception: Low-voltage lighting.

R404.1.1 Lighting equipment (Mandatory).
Fuel gas lighting systems shall not have continuously burning pilot lights.

SECTION R405
SIMULATED PERFORMANCE ALTERNATIVE (PERFORMANCE)

R405.1 Scope.
This section establishes criteria for compliance using simulated energy performance analysis. Such analysis shall include those items identified in Table 405.5.2(1), as applicable. ~~heating, cooling and service water heating energy only~~. A North Carolina licensed design professional is required to perform the analysis if required by North Carolina licensure laws.

R405.2 Mandatory requirements.
Compliance with this section requires that the mandatory provisions identified in Section R401.2(2) be met. ~~All supply and return ducts not completely inside the *building thermal envelope* shall be insulated to a minimum of R-6.~~

R405.3 Performance-based compliance.
Compliance based on simulated energy performance requires that a proposed residence (*proposed design)* be shown to have an annual energy cost that is less than or equal to the annual energy cost of the *standard reference design.* Energy prices shall be taken from a source *approved* by the *code official,* such as the Department of Energy, Energy Information Administration's *State Energy Price and Expenditure Report. Code officials* shall be permitted to require time-of-use pricing in energy cost calculations.

Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

R405.4 Documentation.
Documentation of the software used for the performance design and the parameters for the building shall be in accordance with Sections R405.4.1 through R405.4.3.

R405.4.1 Compliance software tools.
Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *code official.*

R405.4.2 Compliance report.
Compliance software tools shall generate a report that documents that the *proposed design* complies with Section R405.3. A compliance report on the *proposed design* shall be submitted. ~~with the application for the building permit~~. ~~Upon completion of the building, a compliance report based on the as-built condition of the building shall be submitted to the *code official* before a certificate of occupancy is issued. Batch sampling of buildings to determine energy code compliance for all buildings in the batch shall be prohibited.~~

~~Compliance reports shall include information in accordance with Sections R405.4.2.1 and R405.4.2.2. Where the *proposed design* of a building could be built on different sites where the cardinal orientation of the building on each site is different, compliance of the *proposed design* for the purposes of the application for the building permit shall be based on the worst-case orientation, worst-case configuration, worst-case building air leakage and worst- case duct leakage. Such worst-case parameters shall be used as inputs to the compliance software for energy analysis~~.

~~R405.4.2.1 Compliance report for permit application~~.
A compliance report ~~submitted with the application for building permit~~ shall include the following:

1. Building street address, or other building site identification.

2. A statement indicating that the *proposed design* complies with Section R405.3.

3. An inspection checklist documenting the building component characteristics of the *proposed design* as indicated in Table R405.5.2(1). The inspection checklist shall show results for both the *standard reference design* and the *proposed design* with user inputs to the compliance software to generate the results.

4. A site-specific energy analysis report that is in compliance with Section R405.3.

5. The name of the individual performing the analysis and generating the report.

6. The name and version of the compliance software tool.

~~**R405.4.2.2 Compliance report for certificate of occupancy.**~~
~~A compliance report submitted for obtaining the certificate of occupancy shall include the following:~~

~~1. Building street address, or other building site identification.~~

~~2. A statement indicating that the as-built building complies with Section R405.3.~~

~~3. A certificate indicating that the building passes the performance matrix for code compliance and listing the energy saving features of the buildings.~~

~~4. A site-specific energy analysis report that is in compliance with Section R405.3.~~

~~5. The name of the individual performing the analysis and generating the report.~~

~~6. The name and version of the compliance software tool.~~

R405.4.3 Additional documentation.
The *code official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *standard reference design.*

2. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table R405.5.2(1).

3. Documentation of the actual values used in the software calculations for the *proposed design.*

R405.5 Calculation procedure.
Calculations of the performance design shall be in accordance with Sections R405.5.1 and R405.5.2.

R405.5.1 General.
Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

R405.5.2 Residence specifications.

The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table R405.5.2(1). Table R405.5.2(1) shall include, by reference, all notes contained in Table R402.1.2.

TABLE R405.5.2(1)
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass wall if proposed wall is mass; otherwise wood frame.	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table R402.1.4	As proposed
	Solar absorptance = 0.75	As proposed
	Emittance = 0.90	As proposed
Basement and crawl space walls	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: from Table R402.1.4, with insulation layer on interior side of walls	As proposed
Above-grade floors	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table R402.1.4	As proposed
Ceilings	Type: wood frame	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table R402.1.4	As proposed
Roofs	Type: composition shingle on wood sheathing	As proposed
	Gross area: same as proposed	As proposed
	Solar absorptance = 0.75	As proposed
	Emittance = 0.90	As proposed
Attics	Type: vented with aperture = 1 ft^2 per 300 ft^2 ceiling area	As proposed
Foundations	Type: same as proposed	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed	As proposed
Opaque doors	Area: 40 ft^2	As proposed
	Orientation: North	As proposed
	U-factor: same as fenestration from Table R402.1.4	As proposed
Vertical fenestration other than opaque doors	Total area[h] = (a)The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area (b)15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	U-factor: as specified in Table R402.1.4	As proposed

	SHGC: as specified in Table R402.1.2 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
	Interior shade fraction: 0.92-(0.21 × SHGC for the standard reference design)	0.92-(0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed
Air exchange rate	Air leakage rate of ~~5 air changes per hour in climate zones 1 and 2, and 3~~ 5 air changes per hour in climate zones 3 through 5 ~~8~~ at a pressure of 0.2 inches w.g (50 Pa). The mechanical ventilation rate shall be in addition to the air leakage rate and the same as in the proposed design, but no greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms Energy recovery shall not be assumed for mechanical ventilation.	For residences that are not tested, the same air leakage rate as the standard reference design. For tested residences, the measured air exchange rate[a]. The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as proposed.

TABLE R405.5.2(1)—continued
SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Mechanical ventilation	None, except where mechanical ventilation is specified by the proposed design, in which case: Annual vent fan energy use: $\text{kWh/yr} = 0.03942 \times CFA + 29.565 \times (N_{br} + 1)$ where: *CFA* = conditioned floor area N_{br} = number of bedrooms	As proposed
Internal gains	$\text{IGain} = 17{,}900 + 23.8 \times CFA + 4104 \times N_{br}$ (Btu/day per dwelling unit)	Same as standard reference design.
Internal mass	An internal mass for furniture and contents of 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[c] but not inte-

		gral to the building envelope or structure.
Structural mass	For masonry floor slabs, 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls, as proposed, but with insulation required by Table R402.1.4 located on the interior side of the walls	As proposed
	For other walls, for ceilings, floors, and interior walls, wood frame construction	As proposed
Heating systems[d, e]	As proposed for other than electric heating without a heat pump, where the proposed design utilizes electric heating without a heat pump the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC-Commercial Provisions. Capacity: sized in accordance with Section R403.7	As proposed
Cooling systems[d, f]	As proposed Capacity: sized in accordance with Section R403.7.	As proposed
Service water heating[d, ~~e, f,~~ g]	As proposed Use: same as proposed design	As proposed gal/day = 30 + (10 × N_{br})

Thermal distribution systems	Duct insulation: From Section ~~R403.2.1~~ R403.3.1 A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floor* area at a pressure of differential of 0.1 inches w.g. (25 Pa).	As tested or as specified in Table R405.5.2(2) if not tested. Duct insulation shall be same as standard reference design ~~as proposed~~.
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F	Same as standard reference

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the *code official*, testing shall be conducted by an *approved* party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals*, or the equivalent shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE *Handbook of Fundamentals*, page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element must be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or must be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner with the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.
g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater with the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For the case of a proposed design without a proposed water heater, a 40-gallon storage-type water heater with the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.
h. For residences with conditioned basements, R-2 and R-4 residences and townhouses, the following formula shall be used to determine the glazing area:
$AF = A_s \times FA \times F$
Where:
AF = Total glazing area
A_S = Standard reference design total glazing area
FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 x below-grade boundary wall area)
F = (Above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.
And where:
Thermal boundary wall is any wall that separates conditioned space from *unconditioned space* or ambient conditions.
Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
Below-grade boundary wall is any thermal boundary wall in soil contact.
Common wall area is the area of walls shared with an adjoining dwelling unit.
L and CFA are in the same units.

TABLE R405.5.2(2)

DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in *unconditioned space*	—	0.95
Untested distribution systems entirely located in conditioned space[c]	0.88	1
“Ductless” systems[d]	1	—

For SI: 1 cubic foot per minute = 0.47 L/s, 1 square foot = 0.093 m^2, 1 pound per square inch = 6895 Pa, 1 inch water gauge = 1250 Pa.
a. Default values given by this table are for untested distribution systems, which must still meet minimum requirements for duct system insulation.
b. Hydronic systems shall mean those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed-loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.
c. Entire system in conditioned space shall mean that no component of the distribution system, including the air-handler unit, is located outside of the conditioned space.
d. Ductless systems shall be allowed to have forced airflow across a coil but shall not have any ducted airflow external to the manufacturer’s air-handler enclosure.

R405.6 Calculation software tools.

Calculation software, where used, shall be in accordance with Sections R405.6.1 through R405.6.3.

R405.6.1 Minimum capabilities.

Calculation procedures used to comply with this section shall be software tools capable of calculating the annual energy consumption of all building elements that differ between the *standard reference design* and the *proposed design* and shall include the following capabilities:

1. Computer generation of the *standard reference design* using only the input for the *proposed design.* The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design.*

2. Calculation of whole-building (as a single *zone*) sizing for the heating and cooling equipment in the *standard reference design* residence in accordance with Section R403.6.

3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.

4. Printed *code official* inspection checklist listing each of the *proposed design* component characteristics from Table R405.5.2(1) determined by the analysis to provide compliance, along with their respective performance ratings (*R*-value, *U*-factor, SHGC, HSPF, AFUE, SEER, EF are some examples).

R405.6.2 Specific approval.
Performance analysis tools meeting the applicable provisions of Section R405 shall be permitted to be *approved.* Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.

R405.6.3 Input values.
When calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an *approved* source.

SECTION R406
ENERGY RATING INDEX COMPLIANCE ALTERNATIVE

R406.1 Scope.
This section establishes criteria for compliance using an Energy Rating Index (ERI) analysis.

R406.2 Mandatory requirements.
Compliance with this section requires that the ~~mandatory~~ provisions identified in Sections ~~R401.2~~ R401 through R404 labeled as “mandatory” ~~and Section R403.5.3~~ be met. The building thermal envelope shall be greater than or equal to levels of efficiency and Solar Heat Gain Coefficient in Table 402.1.1 or 402.1.3 of the ~~2009 *International Energy Conservation Code*~~ *2012 NC 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 licensed design professional is required to perform the analysis if required by North Carolina licensure laws.

Exception: ~~Supply and return ducts not completely inside the building thermal envelope shall be insulated to a minimum of R-6.~~ 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.

R406.3 Energy Rating Index.
The Energy Rating Index (ERI) shall be a numerical integer value that is based on a linear scale constructed such that the *ERI reference design* has an Index value of 100 and a *residential building* that uses no net purchased energy has an Index value of 0. Each integer value on the scale shall represent a 1-percent change in the total energy use of the rated design relative to the total energy use of the *ERI reference design*. The ERI shall consider all energy used in the *residential building*.

R406.3.1 ERI reference design.
The *ERI reference design* shall be configured such that it meets the minimum requirements of the 2006 *International Energy Conservation Code* prescriptive requirements**.**

The proposed *residential building* shall be shown to have an annual total normalized modified load less than or equal to the annual total loads of the *ERI reference design*.

R406.4 ERI-based compliance.
Compliance based on an ERI analysis requires that the *rated design* be shown to have an ERI less than or equal to the appropriate value listed in Table R406.4.1 or Table R406.4.2, as applicable, when compared to the *ERI reference design*.

~~TABLE R406.4~~
~~MAXIMUM ENERGY RATING INDEX~~

~~CLIMATE ZONE~~	~~ENERGY RATING INDEX~~
~~1~~	~~52~~
~~2~~	~~52~~
~~3~~	~~51~~
~~4~~	~~54~~
~~5~~	~~55~~
~~6~~	~~54~~
~~7~~	~~53~~
~~8~~	~~53~~

TABLE R406.4.1 MAXIMUM ENERGY RATING INDEX without calculation of on-site renewable energy

Climate Zone	Jan 1, 2019 – Dec 31, 2022	Jan 1, 2023 and forward

3	65	61
4	67	63
5	67	63

TABLE R406.4.2 MAXIMUM ENERGY RATING INDEX including calculation of on-site renewable energy

Climate Zone	Jan 1, 2019 – Dec 31, 2022	Jan 1, 2023 and forward
3	51	47
4	54	50
5	55	51

R406.5 Verification ~~by approved agency~~.
Verification of compliance with Section R406 shall be performed by the licensed design professional and the compliance documentation shall be provided to the code official. The code official shall inspect according to the requirements of Section R406.6.2 ~~completed by an *approved* third party~~.

R406.6 Documentation.
Documentation of the software used to determine the ERI and the parameters for the residential building shall be in accordance with Sections R406.6.1 through R406.6.3.

R406.6.1 Compliance software tools.
~~Documentation verifying that the methods and accuracy of the compliance software tools conform to the provisions of this section shall be provided to the *code official*.~~ Compliance software tools for this section shall be in compliance with ANSI RESNET ICC Standard 301-2014.

R406.6.2 Compliance report.
Compliance software tools shall generate a report that documents that the ERI of the *rated design* complies with Sections R406.3 and R406.4. The compliance documentation shall include the following information:

1. Address or other identification of the residential building.
2. An inspection checklist documenting the building component characteristics of the *rated design*. The inspection checklist shall show results for both the *ERI reference design* and the *rated design*, and shall document all inputs entered by the user necessary to reproduce the results.
3. Name of individual completing the compliance report.
4. Name and version of the compliance software tool.

~~**Exception:** Multiple orientations. Where an otherwise identical building model is offered in multiple orientations, compliance for any orientation shall be permitted by~~

~~documenting that the building meets the performance requirements in each of the four (north, east, south and west) cardinal orientations.~~

R406.6.3 Additional documentation.
Deleted. ~~The *code official* shall be permitted to require the following documents:~~

1. ~~Documentation of the building component characteristics of the *ERI reference design*.~~

2. ~~A certification signed by the builder providing the building component characteristics of the *rated design*.~~

3. ~~Documentation of the actual values used in the software calculations for the *rated design*.~~

R406.7 Calculation software tools.
Calculation software, where used, shall be in accordance with Sections R406.7.1 through R406.7.3.

R406.7.1 Minimum capabilities.
Calculation procedures used to comply with this section shall be software tools capable of calculating the ERI as described in Section R406.3, and shall be in compliance with ANSI RESNET ICC Standard 301-2014 ~~and shall include the following capabilities~~. The software shall include the following capabilities:

1. Computer generation of the *ERI reference design* using only the input for the *rated design*.

The calculation procedure shall not allow the user to directly modify the building component characteristics of the *ERI reference design*.

2. Calculation of whole building, as a single *zone*, sizing for the heating and cooling equipment in the *ERI reference design* residence in accordance with Section R403.7.

3. Calculations that account for the effects of indoor and outdoor temperatures and part-load ratios on the performance of heating, ventilating and air-conditioning equipment based on climate and equipment sizing.

4. Printed *code official* inspection checklist listing each of the *rated design* component characteristics determined by the analysis to provide compliance, along with their respective performance ratings.

R406.7.2 Specific approval.
Deleted. ~~Performance analysis tools meeting the applicable sections of Section R406 shall be *approved*. Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall approve tools for a specified application or limited scope.~~

R406.7.3 Input values.
Deleted. ~~When calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from an approved source.~~

CHAPTER 5 [RE]
EXISTING BUILDINGS

SECTION R501
GENERAL

R501.1 Scope.
The provisions of this chapter shall control the *alteration*, repair, addition and change of occupancy of existing buildings and structures. When a section is identified to apply, the subsections to that section also apply.

R501.1.1 Additions, alterations, or repairs: General.
Additions, alterations, or repairs to an existing building, building system or portion thereof shall comply with Section R502, R503 or R504. Unaltered portions of the existing building or building supply system shall not be required to comply with this code.

R501.2 Existing buildings.
Except as specified in this chapter, this code shall not be used to require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system lawfully in existence at the time of adoption of this code.

R501.3 Maintenance. Deleted. ~~Buildings and structures, and parts thereof, shall be maintained in a safe and sanitary condition. Devices and systems that are required by this code shall be maintained in conformance to the code edition under which installed. The owner or the owner's authorized agent shall be responsible for the maintenance of buildings and structures. The requirements of this chapter shall not provide the basis for removal or abrogation of energy conservation, fire protection and safety systems and devices in existing structures.~~

R501.4 Compliance.
Alterations, *repairs*, *additions* and changes of occupancy to, or relocation of, existing buildings and structures shall comply with the provisions for *alterations*, *repairs*, *additions* and changes of occupancy or relocation, respectively, in the *International Residential Code*, *International Building Code*, *International Fire Code*, *International Fuel Gas Code*, *International Mechanical Code*, *International Plumbing Code*, the NC Existing Building Code, ~~*International Property Maintenance Code*, *International Private Sewage Disposal Code*~~ and NFPA 70.

R501.5 New and replacement materials.
Except as otherwise required or permitted by this code, materials permitted by the applicable code for new construction shall be used. Like materials shall be permitted for repairs, provided hazards to life, health or property are not 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.

R501.6 Historic buildings.
No provision of this code relating to the construction, *repair, alteration,* restoration and

movement of structures, and *change of occupancy* shall be mandatory for *historic buildings.* ~~provided a report has been submitted to the code official and signed by the owner, a registered *design professional*, or a representative of the State Historic Preservation Office or the historic preservation authority having jurisdiction, demonstrating that compliance with that provision would threaten, degrade or destroy the historic form, fabric or function of the *building*.~~

SECTION R502
ADDITIONS

R502.1 General.
Additions to an existing building, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. Additions shall not create an unsafe or hazardous condition or overload existing building systems. An addition shall be deemed to comply with this code where the addition alone complies, where the existing building and addition comply with this code as a single building, or where the building with the addition uses no more energy than the existing building. Additions shall be in accordance with Section R502.1.1 or R502.1.2.

R502.1.1 Prescriptive compliance.
Additions shall comply with Sections R502.1.1.1 through R502.1.1.4.

R502.1.1.1 Building envelope.
New building thermal envelope assemblies that are part of the addition shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.4.

~~**Exception:** Where nonconditioned space is changed to conditioned space, the building envelope of the addition shall comply where the UA, as determined in Section 402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to UA generated for the existing building.~~

R502.1.1.2 Heating and cooling systems.
New heating, cooling and duct systems that are part of the addition shall comply with Sections R403.1, R403.2, R403.3, R403.4 ~~R403.5~~ and R403.6. New heating and cooling appliances shall be sized in accordance with Section R403.7. Extensions of ducts from an existing system to a new addition shall require that the existing system be evaluated for the new design.

Exception: ~~Where ducts from an existing heating and cooling system are extended to an addition, 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.~~ Installation of an addition to an existing duct system shall not require a duct leakage test.

R502.1.1.3 Service hot water systems.
New service hot water systems that are part of the addition shall comply with Section R403.5 ~~R403.4~~.

R502.1.1.4 Lighting.
New lighting systems that are part of the addition shall comply with Section R404.1.

R502.1.2 ~~Existing plus Addition compliance (~~Simulated Performance Alternative <u>for Addition</u>~~)~~.
~~Where nonconditioned space is changed to conditioned space, the addition shall comply where the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building when modeled in accordance with Section R405.~~ The addition ~~and any alterations that are part of the project~~ shall comply with Section R405 ~~in its entirety~~<u>, as applicable</u>.

SECTION R503
ALTERATIONS

R503.1 General.
~~*Alterations* to any building or structure shall comply with the requirements of the code for new construction. *Alterations* shall be such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.~~

Alterations to an existing building, building system or portion thereof shall conform to the provisions of this code as they relate to new construction without requiring the unaltered portions of the existing building or building system to comply with this code. Alterations shall not create an unsafe or hazardous condition or overload existing building systems. ~~*Alterations* shall be such that the existing building or structure uses no more energy than the existing building or structure prior to the *alteration*.~~ Alterations to existing buildings shall comply with Sections R503.1.1 through R503.2.

R503.1.1 Building envelope.
Building envelope assemblies that are part of the alteration shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through <u>R402.2.15</u> ~~R402.2.13~~, R402.3.1, R402.3.2, <u>R402.4.4</u> ~~R402.4.3~~ and R402.4.6.

Exception: The following alterations <u>to conditioned spaces</u> need not comply with the requirements for new construction ~~provided the energy use of the building is not increased~~:

1. Storm windows installed over existing fenestration.

2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are insulated. <u>Roof systems requiring air space for ventilation shall retain the ventilation space required.</u>

3. Construction where the existing roof, wall or floor cavity is not exposed.

4. Roof recover <u>and roof replacement such that the existing building or structure is no less conforming to the provisions of this code than the existing building or structure was prior to the *alteration*.</u>

5. Deleted. ~~Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.~~

6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain. ~~provided the code does not require the glazing or fenestration assembly to be replaced~~

7. Converting unconditioned attic space to conditioned attic space for one and two-family dwellings and townhouses. Ceilings shall be insulated to a minimum of R-30, walls shall be insulated to the exterior wall requirements in Table 402.1.2 or Table 402.1.4 and follow the backing requirements in Section 402.2.14 and 402.2.15.

R503.1.1.1 Replacement fenestration.
~~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 provided in Table R402.1.2.~~
Where an entire existing fenestration unit is replaced with a new fenestration product, including frame, sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC in Table R402.1.2.

Exception: Alterations that replace less than 50% of entire fenestration units may be replaced with like or better fenestration units to match existing fenestration assemblies.

R503.1.2 Heating and cooling systems.
New heating, cooling and duct systems that are part of the alteration shall comply with Sections R403.1, R403.2, R403.3, 403.4, ~~and~~ R403.6, and R403.7.

Exception: ~~Where ducts from an existing heating and cooling system are extended, 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.~~ An alteration involving a partial system replacement to an existing duct system shall not require a duct leakage test.

R503.1.3 Service hot water systems.
New service hot water systems that are part of the alteration shall comply with Section R403.5 ~~R403.4~~.

R503.1.4 Lighting.
New lighting systems that are part of the alteration shall comply with Section R404.1.

Exception: Alterations that replace less than 50 percent of the luminaires in a space, provided that such alterations do not increase the installed interior lighting power.

R503.2 Change in space conditioning.
~~Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.~~

~~**Exception:** Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.3.~~

New work performed shall meet the requirements of this code.
Projects changing *unconditioned space* to conditioned space and costing more than $10,000 shall require 10% of the project cost to be used toward meeting the requirements of Chapter 11 of the North Carolina Residential Code for one- and two-family dwellings and townhouses or the North Carolina Energy Conservation Code. Project costs for the purpose of this section is the total project cost listed on all permits related to the work required to convert the *unconditioned space* to conditioned space and excludes the 10% added from this section. Under this section, existing building envelope elements that become a part of the building thermal envelope and are not changed are not required to be upgraded. The additional 10% of the project cost shall be appropriated for additional energy conservation features of choice that are addressed in Chapter 11 of the North Carolina Residential Code for one- and two-family dwellings and townhouses or the North Carolina Energy Conservation Code. In addition to the 10% project cost, any existing wall, ceiling, or floor cavities that are exposed during construction shall at a minimum be insulated to comply with Chapter 11 of the North Carolina Residential Code for one- and two-family dwellings and townhouses or the North Carolina Energy Conservation Code or be insulated to fill the cavity, whichever is less. Roof systems requiring air space for ventilation shall retain the ventilation space required. Projects costing less than $10,000 are not subject to the 10% project cost addition provision.

SECTION R504
REPAIRS

R504.1 General.
Repair of the building ~~insulation~~ systems shall not make the building less conforming than it was before the *repair* was undertaken. ~~Buildings, structures and parts thereof shall be repaired in compliance with Section R501.3 and this section.~~ Work on nondamaged components necessary for the required *repair* of damaged components shall be considered part of the *repair* and shall not be subject to the requirements for *alterations* in this chapter. ~~Routine maintenance required by Section R501.3, ordinary repairs exempt from *permit*, and abatement of wear due to normal service conditions shall not be subject to the requirements for *repairs* in this section.~~

R504.2 Materials ~~Application~~.
Portions of walls that are part of the building thermal envelope shall be insulated in accordance with this code when the repair requires the removal of either the interior or exterior wall membrane such that the wall cavity is exposed during the repair.

~~For the purposes of this code, the following shall be considered repairs:~~

~~1. Glass-only replacements in an existing sash and frame.~~

~~2. Roof repairs.~~

~~3. Repairs where only the bulb and/or ballast within the existing luminaires in a space are replaced provided that the replacement does not increase the installed interior lighting power.~~

Commentary: *This section allows for only the portions of the wall exposed during a repair to meet the minimum insulation requirements of the NC Energy Conservation Code. Unexposed wall cavities are permitted to remain without requiring additional insulation.*

Exception: Wall cavities containing existing insulation material.

Commentary: *This exception provides relief from the full requirements for wall insulation in the NC Energy Conservation Code when the repair exposes an existing wall cavity and it already contains insulation.*

R504.3 Glazing.
Repairs requiring the replacement of individual glass panes or sashes shall not require compliance with this code.

Commentary: *This section requires replacement of an entire window unit to comply with current NC Energy Conservation Code requirements but allows for a single pane or sash to be replaced with glass that matches the existing without reducing the energy efficiency of the building.*

SECTION R505
CHANGE OF OCCUPANCY OR USE

R505.1 General.
~~Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code.~~ New work performed in spaces undergoing a change in occupancy shall comply with the requirements of this code. Unaltered portions of the existing building or building supply system shall not be required to comply with this code.

~~**R505.2 General.**~~
~~Any space that is converted to a dwelling unit or portion thereof from another use or occupancy shall comply with this code.~~

~~**Exception:** Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.3.~~

CHAPTER 6 [RE]
REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 106.

AAMA

American Architectural Manufacturers Association
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-4268

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A C440—11	North American Fenestration Standard/ Specifications for Windows, Doors and Unit Skylights	R402.4.4 ~~3~~

~~ACCA~~

~~Air Conditioning Contractors of America~~
~~2800 Shirlington Road, Suite 300~~
~~Arlington, VA 22206~~

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~Manual J—2011~~	~~Residential Load Calculation Eighth Edition~~	~~R403.7~~
~~Manual S—13~~	~~Residential Equipment Selection~~	~~R403.7~~

APSP

The Association of Pool and Spa Professionals
2111 Eisenhower Avenue
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
~~APSP 14—11~~	~~American National Standard for Portable Electric Spa Energy Efficiency~~	~~R403.10.1, 403.11~~
APSP 15a—2013	American National Standard for Residential Swimming Pool and Spa Energy Efficiency	R403.12

ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
ASHRAE—2013	ASHRAE Handbook of Fundamentals	R402.1.5, Table R405.5.2(1)
~~ASHRAE 193—2010~~	~~Method of Test for Determining the Airtightness of HVAC~~	~~R403.3.2.1~~

~~Equipment~~

ASTM

ASTM International
100 Barr Harbor Drive
West Conshohocken, PA 19428-2859

Standard reference number	Title	Referenced in code section number
C 1363—11	Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus	R303.1.4.1
E 283—04	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen	R402.4.6 ~~4~~
E 779—10	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization	R402.4.2.2 ~~1.2~~
E 1827—11	Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door	R402.4. 2.2 ~~1.2~~

CSA

CSA Group
8501 East Pleasant Valley
Cleveland, OH 44131-5575

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.4 ~~3~~
~~CSA 55.1—2012~~	~~Test Method for measuring efficiency and pressure loss of drain water heat recovery units~~	~~R403.5.4~~
~~CSA 55.2—2012~~	~~Drain water heat recover units~~	~~R403.5.4~~

DASMA

Door and Access Systems Manufacturers Association
1300 Sumner Avenue
Cleveland, OH 44115-2851

Standard reference number	Title	Referenced in code section number
105—92(R2004)—13	Test Method for Thermal Transmittance and Air Infiltration of Garage Doors	R303.1.3

ICC

International Code Council, Inc.
500 New Jersey Avenue, NW
6th Floor
Washington, DC 20001

Standard reference number	Title	Referenced in code section number
IBC—15	International Building Code®	R201.3, R303.2, R402.1.1, R501.4
ANSI/RESNET/ICC 301-14	Standard for the Calculation and Labeling of the Energy Performance of Low-Rise Residential Buildings using an Energy Rating Index	R-406.2,R406.6.1, R406.7.1

~~ICC 400—12~~	~~Standard on the Design and Construction of Log Structures~~	~~Table R402.5.1.1~~
IECC—15	International Energy Conservation Code®	R101.4.1, 403.8
~~IECC—09~~	~~2009 International Energy Conservation Code®~~	~~R406.2~~
ECC—06	2006 International Energy Conservation Code®	R202, R406.3.1
IFC—15	International Fire Code®	R201.3, R501.4
IFGC—15	International Fuel Gas Code®	R201.3, R501.4
IMC—15	International Mechanical Code®	R201.3, R403.3.2, R403.6, R501.4
IPC—15	International Plumbing Code®	R201.3, R501.4
~~IPSDC—15~~	~~International Private Sewage Disposal Code®~~	~~501.4~~
~~IPMC—15~~	~~International Property Maintenance Code®~~	~~501.4~~
IRC—15	International Residential Code®	R201.3, R303.2, ~~R402.1.1,~~ ~~R402.2.11,~~ R403.3.2, R403.6, R501.4

~~IEEE~~

~~The Institute of Electrical and Electronic Engineers, Inc.~~
~~3 Park Avenue~~
~~New York, NY 1016-5997~~

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~515.1—2012~~	~~IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications~~	~~R403.5.1.2~~

NFPA

National Fire Protection Association. 1 Batterymarch Park
Quincy, MA 02169-7471

Standard reference number	Title	Referenced in code section number
70—14	National Electrical Code	R501.4

NFRC

National Fenestration Rating Council, Inc.
6305 Ivy Lane, Suite 140
Greenbelt, MD 20770

Standard reference number	Title	Referenced in code section number
100—2009	Procedure for Determining Fenestration Products *U*-factors—Second Edition	R303.1.3
200—2009	Procedure for Determining Fenestration Product Solar Heat Gain Coefficients and Visible Transmittance at Normal Incidence—Second Edition	R303.1.3
400—2009	Procedure for Determining Fenestration Product Air Leakage—Second Edition	R402.4.4 ~~3~~

~~UL~~

~~UL LLC~~
~~333 Pfingsten Road~~
~~Northbrook, IL 60062~~

~~Standard reference number~~	~~Title~~	~~Referenced in code section number~~
~~127—11~~	~~Standard for Factory Built Fireplaces~~	~~R402.4.2~~
~~515—11~~	~~Electrical Resistance Heat Tracing for Commercial and Industrial Applications including revisions through November 30, 2011~~	~~R403.5.1.2~~

US-FTC

United States-Federal Trade Commission
600 Pennsylvania Avenue NW
Washington, DC 20580

Standard reference number	Title	Referenced in code section number
CFR Title 16 (May 31, 2005)	R-value Rule	R303.1.4

WDMA

Window and Door Manufacturers Association
2025 M Street, NW Suite 800
Washington, DC 20036-3309

Standard reference number	Title	Referenced in code section number
AAMA/WDMA/CSA 101/I.S.2/A440—11	North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights	R402.4.4 ~~3~~

~~APPENDIX RA~~
~~RECOMMENDED PROCEDURE FOR WORST-CASE TESTING OF ATMOSPHERIC VENTING SYSTEMS UNDER R402.4 OR R405 CONDITIONS ≤ 5ACH~~$_{50}$

~~*(This appendix is informative and is not part of the code.)*~~

~~SECTION RA101~~
~~SCOPE~~

~~RA101.1 General.~~
~~This appendix is intended to provide guidelines for worst-case testing of atmospheric venting systems. Worst-case testing is recommended to identify problems that weaken draft and restrict combustion air.~~

~~SECTION RA201~~
~~GENERAL DEFINITIONS~~

~~COMBUSTION APPLIANCE ZONE (CAZ).~~ ~~A contiguous air volume within a building that contains a Category I or II atmospherically vented appliance or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside the building or dwelling unit. The CAZ includes, but is not limited to, a mechanical closet, a mechanical room, or the main body of a house or dwelling unit.~~

~~DRAFT.~~ ~~The pressure difference existing between the *appliance* or any component part and the atmosphere that causes a continuous flow of air and products of *combustion* through the gas passages of the *appliance* to the atmosphere.~~

> **~~Mechanical or induced draft.~~** ~~The pressure difference created by the action of a fan, blower or ejector that is located between the *appliance* and the *chimney* or vent termination.~~
>
> **~~Natural draft.~~** ~~The pressure difference created by a vent or *chimney* because of its height and the temperature difference between the *flue* gases and the atmosphere.~~

~~SPILLAGE.~~ ~~Combustion gases emerging from an appliance or venting system into the combustion appliance zone during burner operation.~~

~~SECTION RA301~~
~~TESTING PROCEDURE~~

~~**RA301.1 Worst-case testing of atmospheric venting systems.**~~
~~Buildings or dwelling units containing a Category I or II atmospherically vented appliance; or a Category III or IV direct-vent or integral vent appliance drawing combustion air from inside of the building or dwelling unit, shall have the Combustion Appliance Zone (CAZ) tested for spillage, acceptable draft and carbon monoxide (CO) in accordance with this section. Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal* envelope and prior to final inspection.~~

> ~~**Exception:** Buildings or dwelling units containing only Category III or IV direct-vent or integral vent appliances that do not draw combustion air from inside of the building or dwelling unit.~~

~~The enumerated test procedure as follows shall be complied with during testing:~~

1. ~~Set combustion appliances to the pilot setting or turn off the service disconnects for combustion appliances. Close exterior doors and windows and the fireplace damper. With the building or dwelling unit in this configuration, measure and record the baseline ambient pressure inside the building or dwelling unit CAZ. Compare the baseline ambient pressure of the CAZ to that of the outside ambient pressure and record the difference (Pa).~~

2. ~~Establish worst case by turning on the *clothes dryer* and all exhaust fans. Close all interior doors that make the CAZ pressure more negative. Turn on the air handler, where present, and leave on if, as a result, the pressure in the CAZ becomes more negative. Check interior door positions again, closing only the interior doors that make the CAZ pressure more negative. Measure net change in pressure from the CAZ to outdoor ambient pressure, correcting for the base ambient pressure inside the home. Record "worst case depressurization" pressure and compare to Table RA301.1(1).~~

   ~~Where CAZ depressurization limits are exceeded under worst-case conditions in accordance with Table A301.1(1), additional combustion air shall be provided or other modifications to building air-leakage performance or exhaust appliances such that depressurization is brought within the limits prescribed in Table RA301.1(1).~~

3. ~~Measure worst-case spillage, acceptable draft and carbon monoxide (CO) by firing the fuel-fired appliance with the smallest Btu capacity first.~~

   a. ~~Test for spillage at the draft diverter with a mirror or smoke puffer. An appliance that continues to spill flue gases for more than 60 seconds fails the spillage test.~~

   b. ~~Test for CO measuring undiluted flue gases in the throat or flue of the appliance using a digital gauge in parts per million (ppm) at the 10-minute mark. Record~~

~~CO ppm readings to be compared with Table RA301.1(3) upon completion of Step 4. Where the spillage test fails under worst case, go to Step 4.~~

~~c. Where spillage ends within 60 seconds, test for acceptable draft in the connector not less than 1 foot (305 mm), but not more than 2 feet (610 mm) downstream of the draft diverter. Record draft pressure and compare to Table RA301.1(2).~~

~~d. Fire all other connected appliances simultaneously and test again at the draft diverter of each appliance for spillage, CO and acceptable draft using procedures 3a through 3c.~~

~~4. Measure spillage, acceptable draft, and carbon monoxide (CO) under natural conditions—without *clothes dryer* and exhaust fans on—in accordance with the procedure outlined in Step 3, measuring the net change in pressure from worst case condition in Step 3 to natural in the CAZ to confirm the worst case depressurization taken in Step 2. Repeat the process for each appliance, allowing each vent system to cool between tests.~~

~~5. Monitor indoor ambient CO in the breathing zone continuously during testing, and abort the test where indoor ambient CO exceeds 35 ppm by turning off the appliance, ventilating the space, and evacuating the building. The CO problem shall be corrected prior to completing combustion safety diagnostics.~~

~~6. Make recommendations based on test results and the retrofit action prescribed in Table RA301.1(3).~~

~~TABLE RA301.1(1)~~
~~CAZ DEPRESSURIZATION LIMITS~~

~~VENTING CONDITION~~	~~LIMIT (Pa)~~
~~Category I, atmospherically vented water heater~~	~~–2.0~~
~~Category I or II atmospherically vented boiler or furnace common-vented with a Category I atmospherically vented water heater~~	~~–3.0~~
~~Category I or II atmospherically vented boiler or furnace, equipped with a flue damper, and common vented with a Category I atmospherically vented water heater~~	~~–5.0~~
~~Category I or II atmospherically vented boiler or furnace alone~~	
~~Category I or II atmospherically vented, fan-assisted boiler or furnace common vented with a Category I atmospherically vented water heater~~	
~~Decorative vented, gas appliance~~	
~~Power-vented or induced-draft boiler or furnace alone, or fan-assisted water heater alone~~	~~–15.0~~
~~Category IV direct-vented appliances and sealed combustion appliances~~	~~–50.0~~

~~For SI: 6894.76 Pa = 1.0 psi.~~

~~TABLE RA301.1(2)~~
~~ACCEPTABLE DRAFT TEST CORRECTION~~

~~**OUTSIDE TEMPERATURE (°F)**~~	~~**MINIMUM DRAFT PRESSURE REQUIRED (Pa)**~~
~~< 10~~	~~–2.5~~
~~10 – 90~~	~~(Outside Temperature ÷ 40) – 2.75~~
~~> 90~~	~~–0.5~~

~~For SI: 6894.76 Pa = 1.0 psi.~~

~~TABLE RA301.1(3)~~
~~ACCEPTABLE DRAFT TEST CORRECTION~~

~~**CARBON MONOXIDE LEVEL (ppm)**~~	~~**AND OR**~~	~~**SPILLAGE AND ACCEPTABLE DRAFT TEST RESULTS**~~	~~**RETROFIT ACTION**~~
~~0 – 25~~	~~and~~	~~Passes~~	~~Proceed with work~~
~~25 < x ≤ 100~~	~~and~~	~~Passes~~	~~Recommend that CO problem be resolved~~
~~25 < x ≤ 100~~	~~and~~	~~Fails in worst case only~~	~~Recommend an appliance service call and repairs to resolve the problem~~
~~100 < x ≤ 400~~	~~or~~	~~Fails under natural conditions~~	~~**Stop!** Work shall not proceed until appliance is serviced and problem resolved~~
~~> 400~~	~~and~~	~~Passes~~	~~**Stop!** Work shall not proceed until appliance is serviced and problem resolved~~
~~> 400~~	~~and~~	~~Fails under any condition~~	~~**Emergency!** Shut off fuel to appliance and call for service immediately~~

~~APPENDIX RB~~

~~SOLAR-READY PROVISIONS—DETACHED ONE- AND TWO-FAMILY DWELLINGS, MULTIPLE SINGLE-FAMILY DWELLINGS (TOWNHOUSES)~~

~~(The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.)~~

~~SECTION RB101~~
~~SCOPE~~

~~RB101.1 General.~~
~~These provisions shall be applicable for new construction where solar-ready provisions are required.~~

~~SECTION RB102~~
~~GENERAL DEFINITION~~

~~SOLAR-READY ZONE.~~ ~~A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.~~

~~SECTION RB103~~
~~SOLAR-READY ZONE~~

~~RB103.1 General.~~
~~New detached one- and two-family dwellings, and multiple single-family dwellings (townhouses) with not less than 600 square feet (55.74 m~~^{2}~~) of roof area oriented between 110 degrees and 270 degrees of true north shall comply with Sections RB103.2 through RB103.8.~~

~~Exceptions:~~

1. ~~New residential buildings with a permanently installed on-site renewable energy system.~~

2. ~~A building with a solar-ready zone that is shaded for more than 70 percent of daylight hours annually.~~

~~RB103.2 Construction document requirements for solar-ready zone.~~
~~Construction documents shall indicate the solar-ready zone.~~

~~RB103.3 Solar-ready zone area.~~

~~The total solar-ready zone area shall be not less than 300 square feet (27.87 m~~^{2}~~) exclusive of mandatory access or set back areas as required by the~~ ~~*International Fire Code*~~~~. New multiple single-family dwellings (townhouses) three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (185.8 m~~^{2}~~) per dwelling shall have a solar-ready zone area of not less than 150 square feet (13.94 m~~^{2}~~). The solar-ready zone shall be composed of areas not less than 5 feet (1524 mm) in width and not less than 80 square feet (7.44 m~~^{2}~~) exclusive of access or set back areas as required by the~~ ~~*International Fire Code*~~~~.~~

~~RB103.4 Obstructions.~~
~~Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.~~

~~RB103.5 Roof load documentation.~~
~~The structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents.~~

~~RB103.6 Interconnection pathway.~~
~~Construction documents shall indicate pathways for routing of conduit or plumbing from the solar-ready zone to the electrical service panel or service hot water system.~~

~~RB103.7 Electrical service reserved space.~~
~~The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled "For Future Solar Electric." The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.~~

~~RB103.8 Construction documentation certificate.~~
~~A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.~~

APPENDIX 1: RESIDENTIAL REQUIREMENTS

APPENDIX 1.1 Energy Efficiency Certificate (Section R401.3)

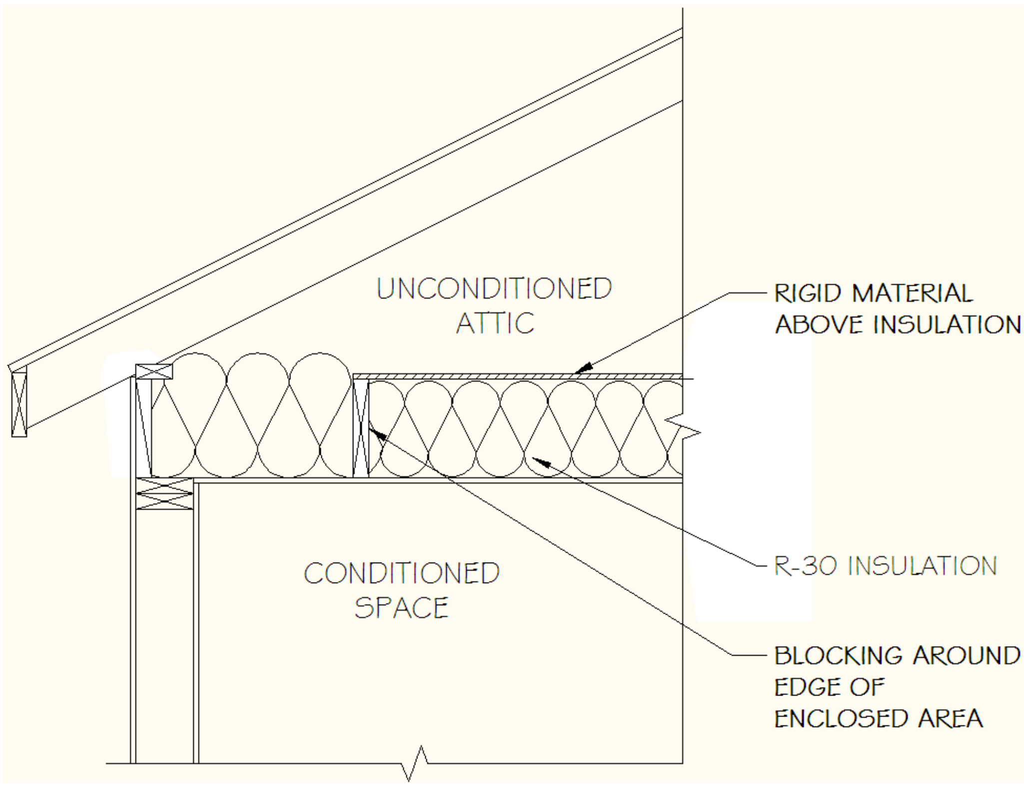
ENERGY EFFICIENCY CERTIFICATE

R401.3

Builder, Permit Holder or Registered Design Professional Print Name: **Signature:**	
Property Address:	
Date:	
Insulation Rating - List the value covering largest area to all that apply	**R-Value**
Ceiling/roof:	**R-**
Wall:	**R-**
Floor:	**R-**
Closed Crawl Space Wall:	**R-**
Closed Crawl Space Floor:	**R-**
Slab:	**R-**
Basement Wall:	**R-**
Fenestration:	
U-Factor	
Solar Heat Gain Coefficient(SHGC)	
Building Air Leakage	
☐ **Visually inspected according to R402.4.2.1 OR**	
☐ **Building Air Leakage Test Results (Sec. R402.4.2.2)** **ACH50 [Target: 5.0]** **or CFM50/SFSA [Target: 0.30]**	
Name of Tester / Company: **Date:** **Phone:**	
Ducts:	
Insulation	**R-**
Total Duct Leakage Test Result (Sect. R403.3.3) **Circle one:** **Total duct leakage test** **(CFM25 Total/100SF) [Target: 5]** **Or** **Duct leakage to the outside test** **(CFM25 Total/100SF) [Target: 4]**	
Name of Tester or Company: **Date:** **Phone:**	
Certificate to be displayed permanently	

APPENDIX 1.2
INSULATION AND AIR SEALING DETAILS

APPENDIX 1.2.1
R402.2.1 Ceilings with attic spaces: Exception for fully enclosed attic floor systems

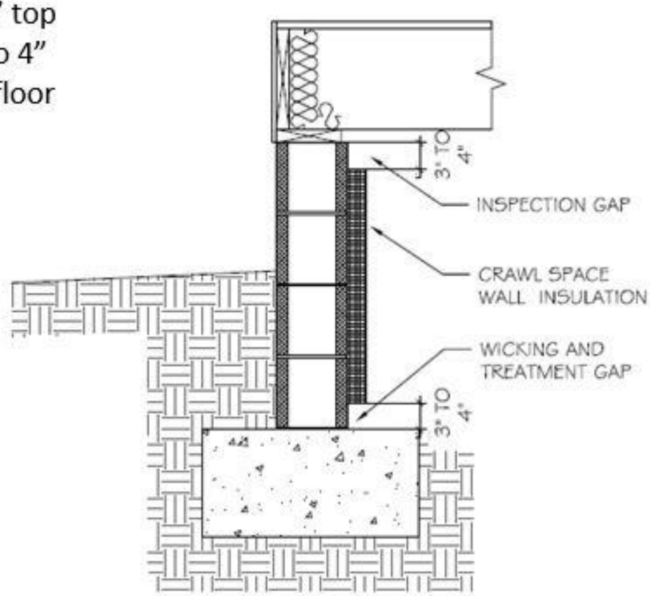


SECTION VIEW OF CEILING WITH ATTIC SPACE

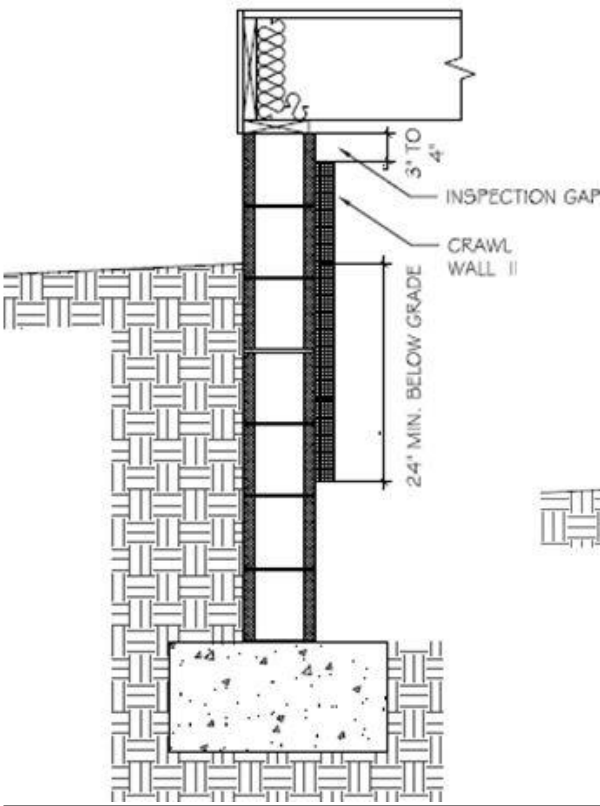
APPENDIX 1.2.2

R402.2.11 Closed crawl space walls. Insulation illustrations

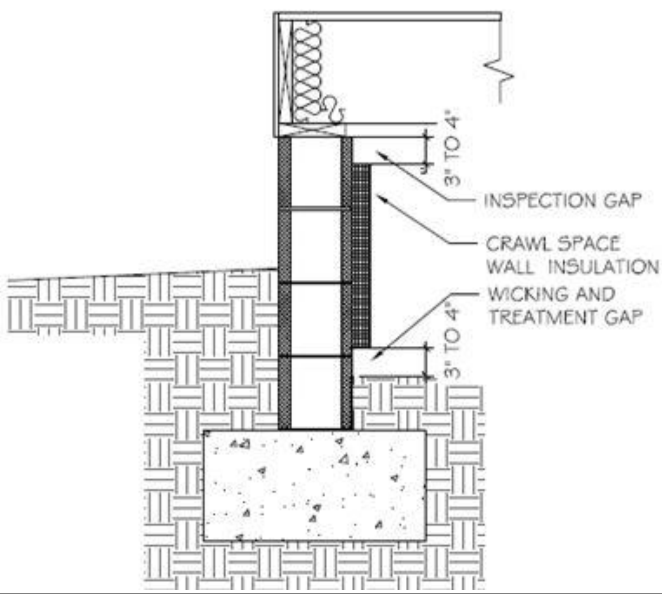
Foam or porous insulation has 3" to 4" top inspection gap and extends down 3" to 4" above top of wall footing or concrete floor



Foam or porous insulation has 3" to 4" top inspection gap and extends down 24" below grade

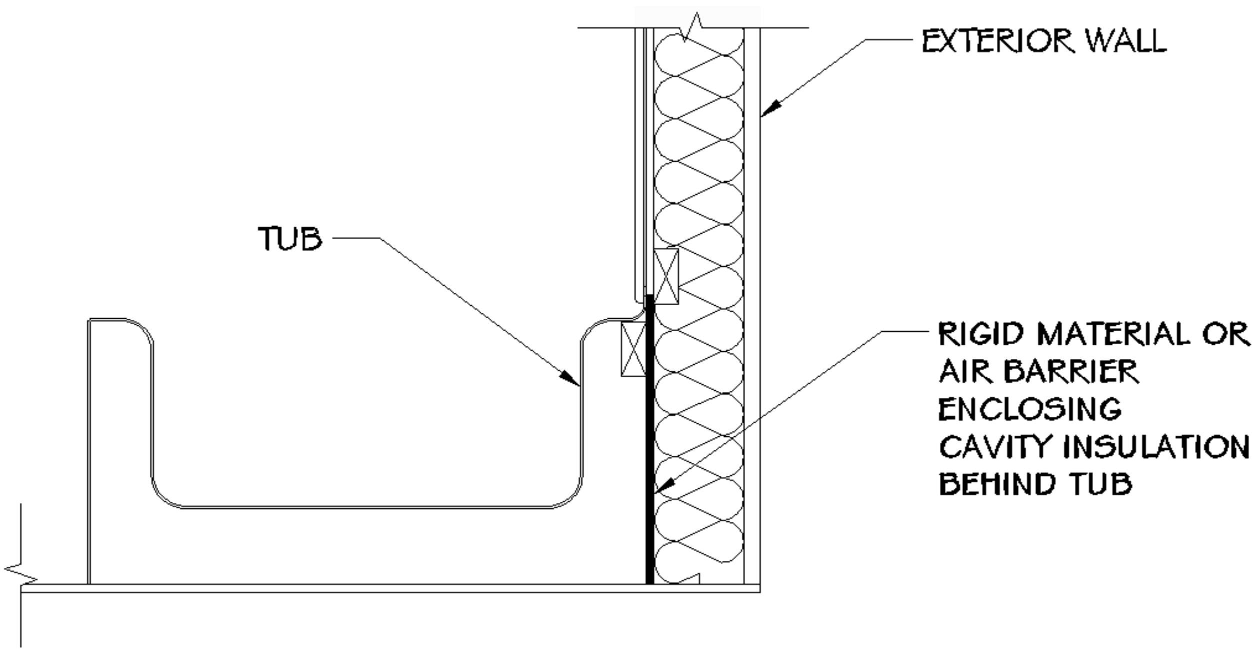


Foam or porous insulation has 3" to 4" top inspection gap and extends down 3" to 4" above interior ground surface



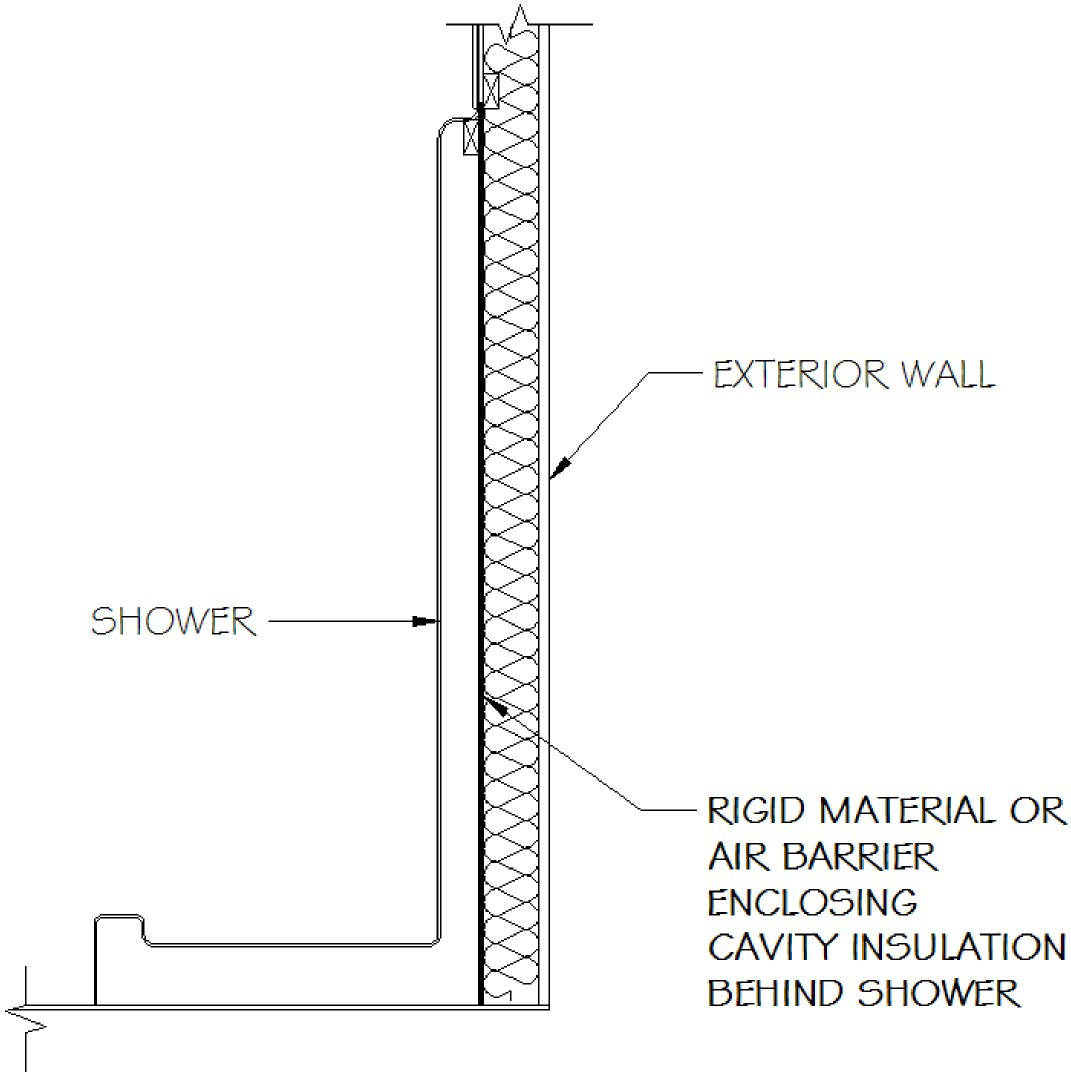
APPENDIX 1.2.3

R402.2.14 Framed cavity walls. Insulation enclosure – 1. Tubs



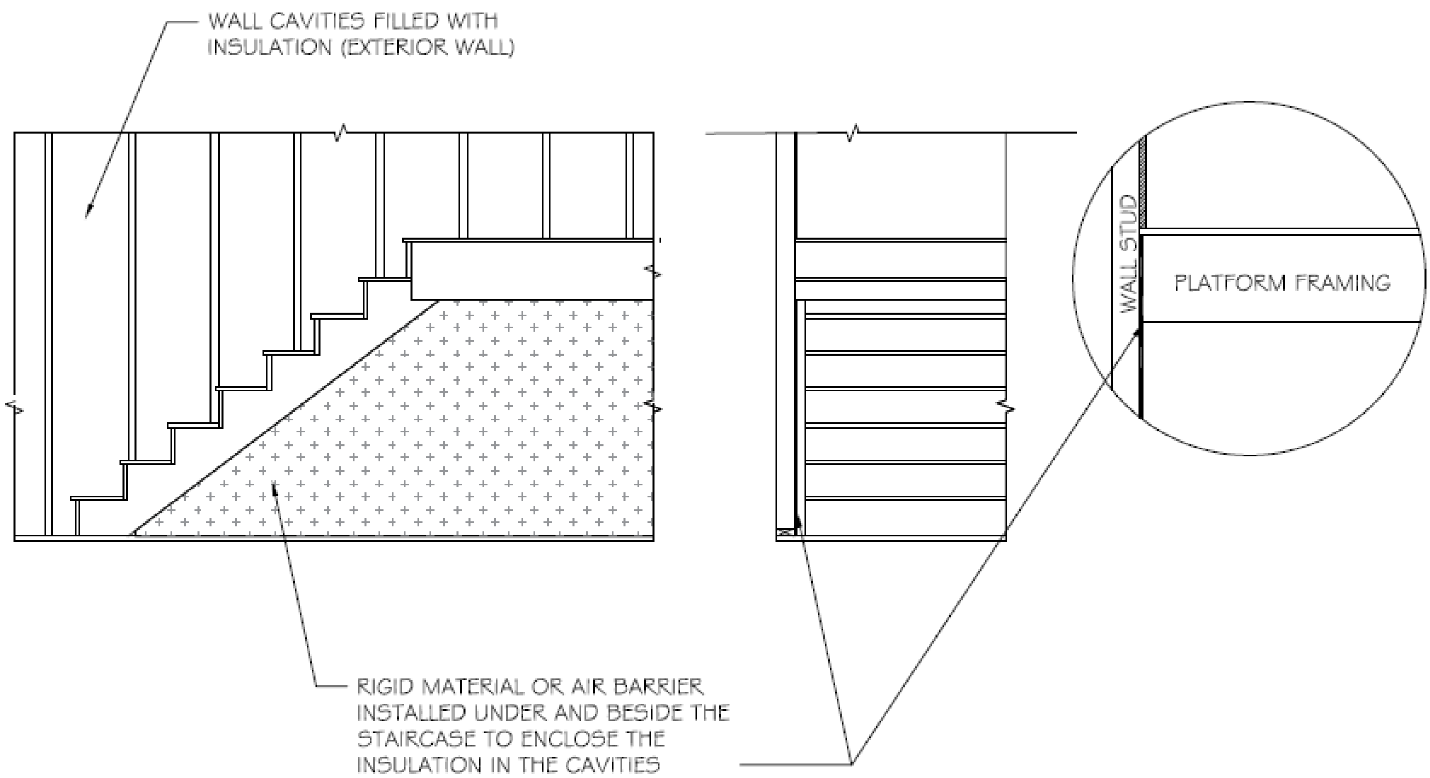
SECTION VIEW OF BATH TUB ON EXTERIOR WALL

R402.2.14 Framed cavity walls. Insulation enclosure – 2. Showers



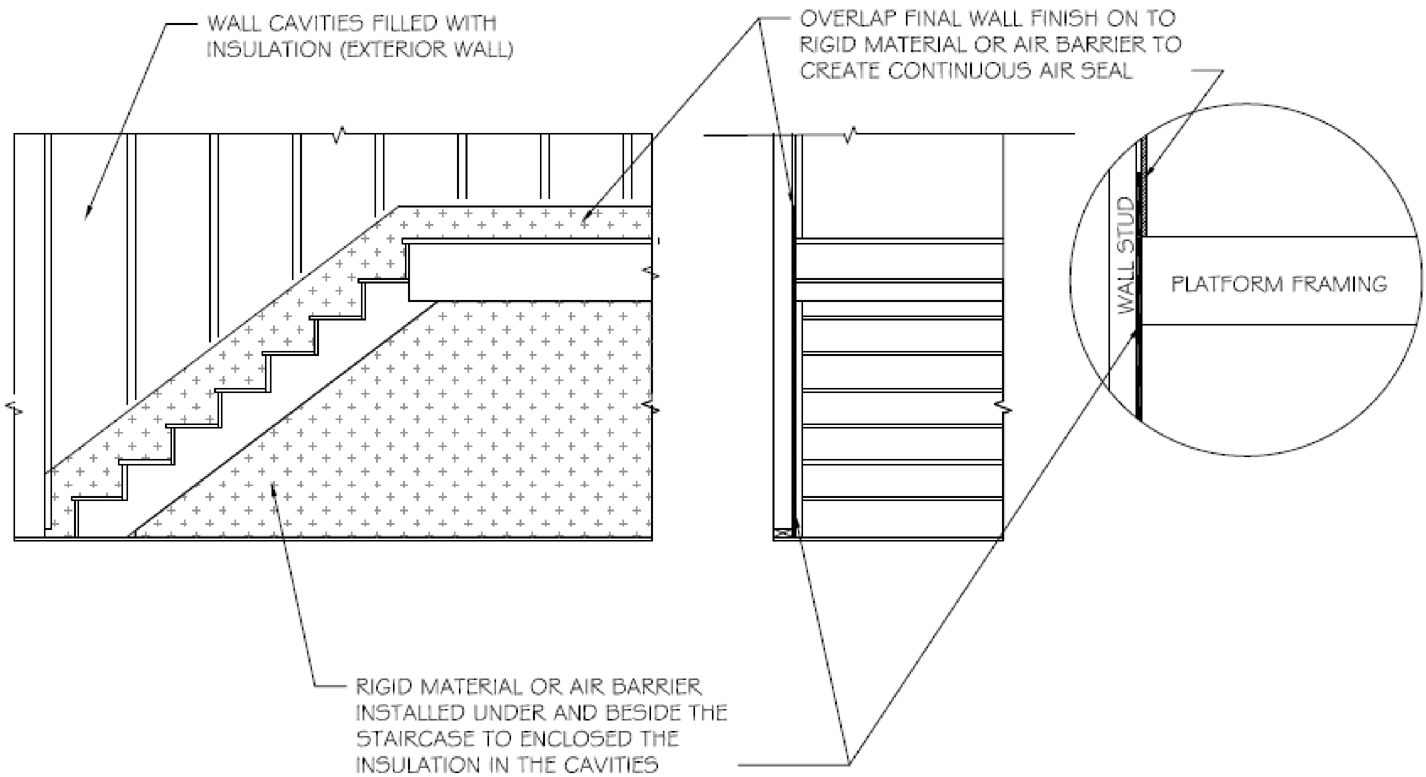
SECTION VIEW OF SHOWER ON EXTERIOR WALL

R402.2.14 Framed cavity walls. Insulation enclosure – 3. Stairs



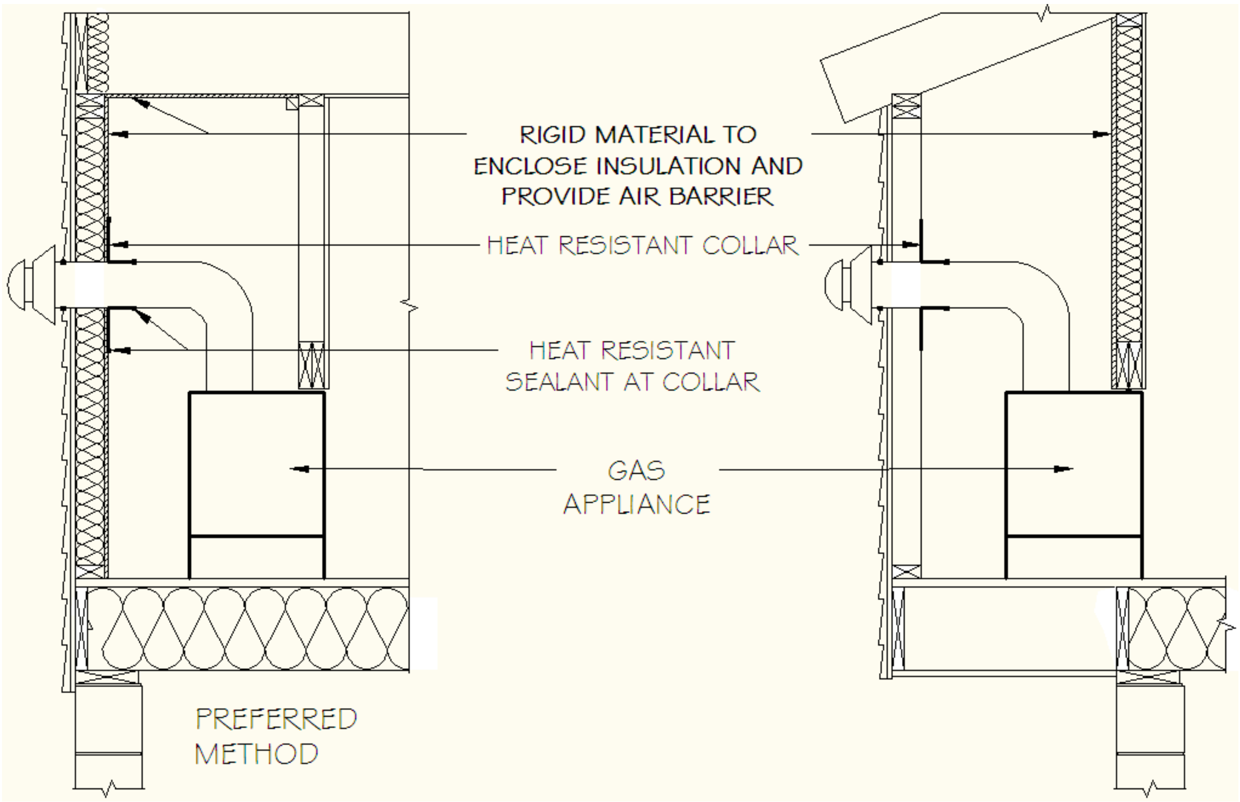
SECTION VIEW OF INTERIOR STAIRCASE ON EXTERIOR WALL (OPTION 1)

R402.2.14 Framed cavity walls. Insulation enclosure – 3. Stairs



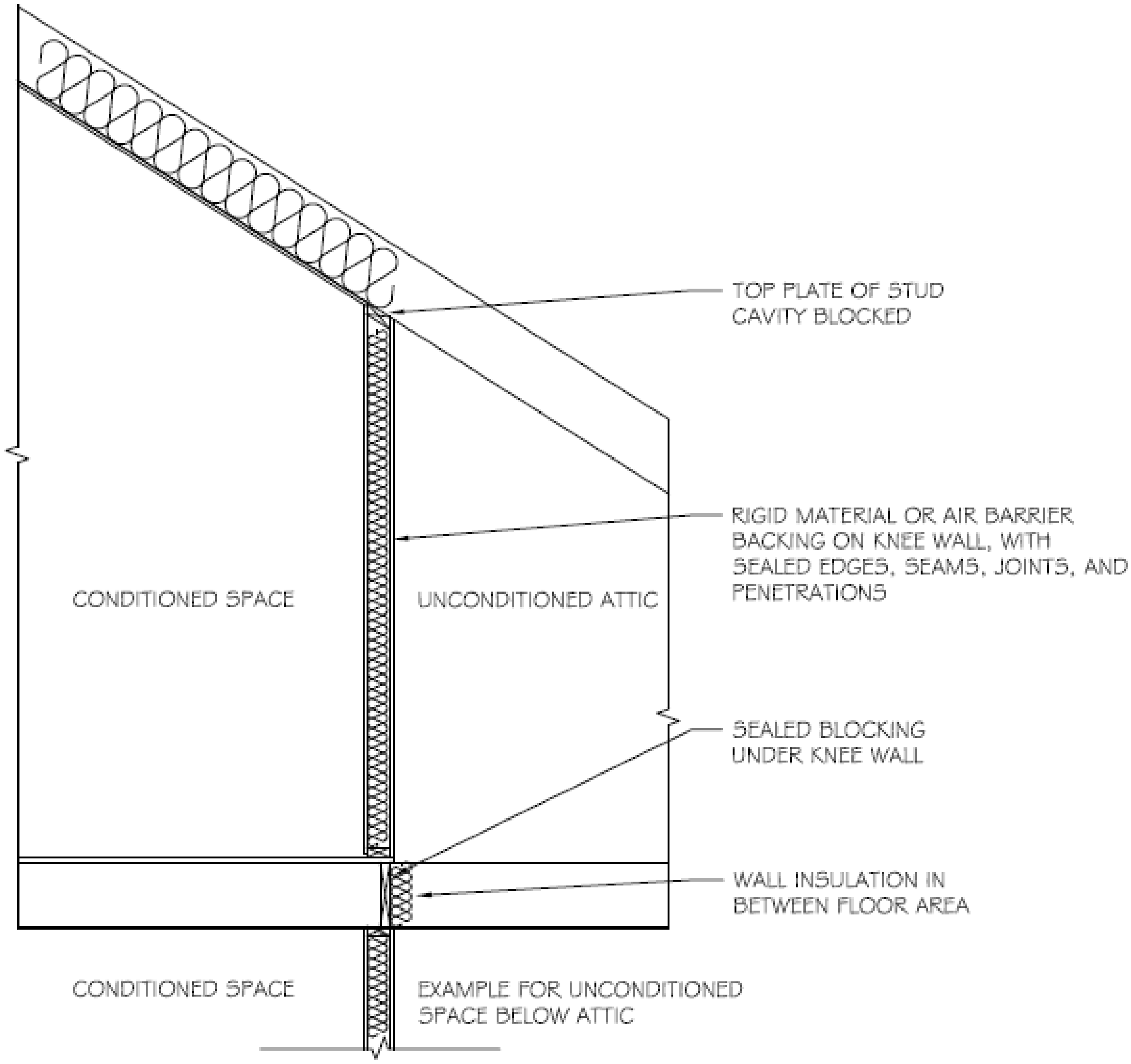
SECTION VIEW OF INTERIOR STAIRCASE ON EXTERIOR WALL (OPTION 2)

R402.2.14 Framed cavity wall. Insulation enclosure – 4. Direct vent gas fireplace



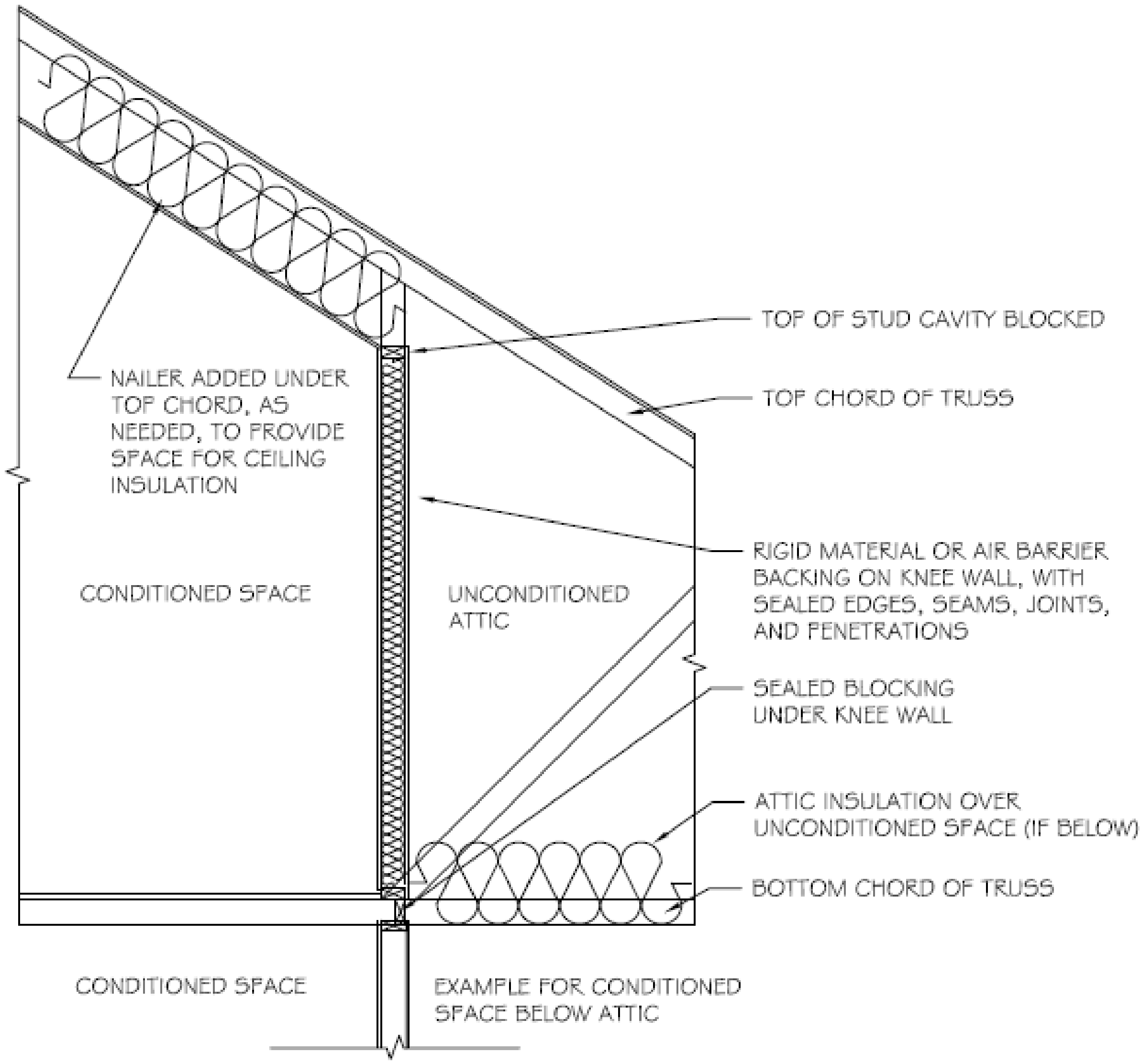
SECTION VIEW OF DIRECT VENT GAS FIREPLACE

R402.2.15 **Framed cavity walls.** Insulation enclosure – 5. Walls that adjoin attic spaces



SECTION VIEW OF WALL ADJOINING ATTIC SPACE WITH STICK FRAMED ROOF

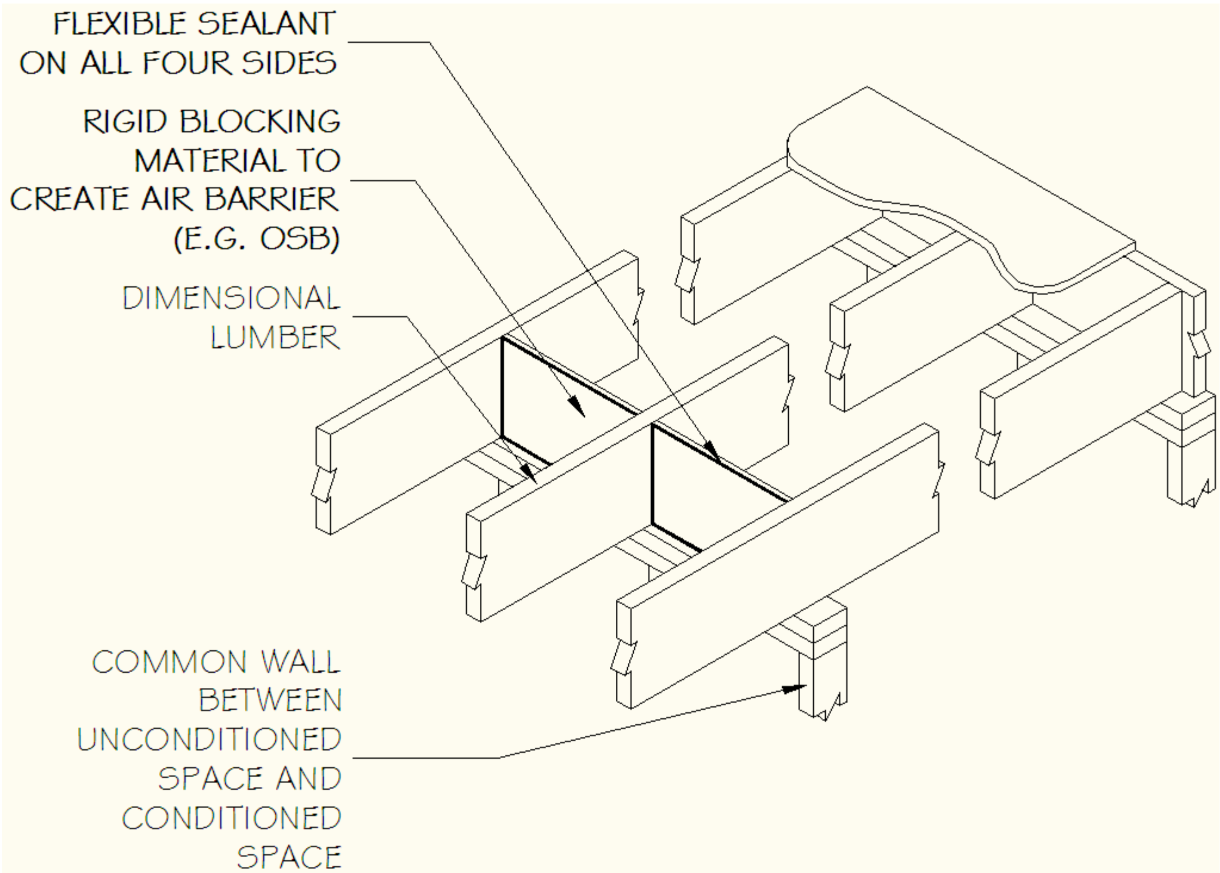
R402.2.15 Framed cavity walls. Insulation enclosure – 5. Walls that adjoin attic spaces



SECTION VIEW OF WALL ADJOINING ATTIC SPACE WITH TRUSS ROOF

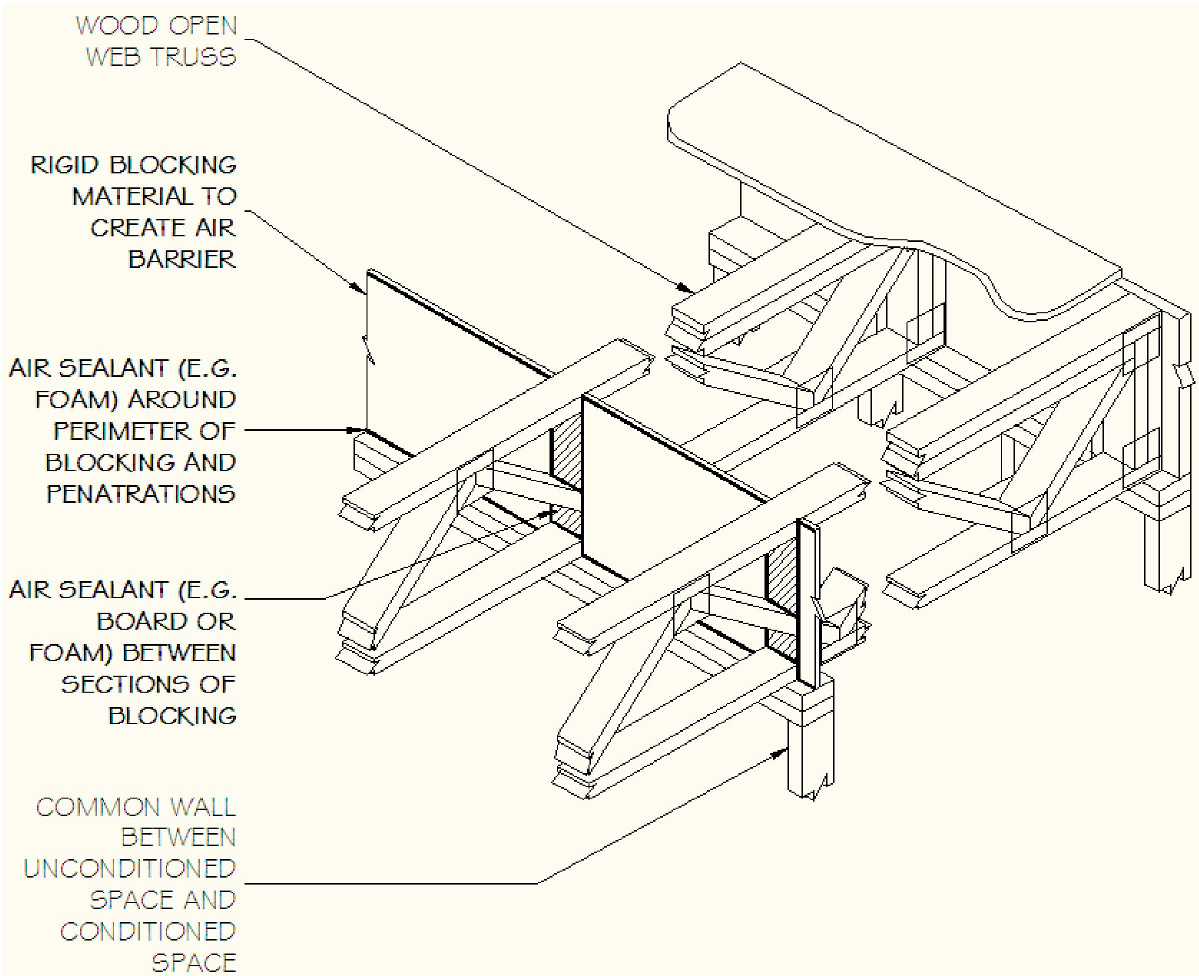
APPENDIX 1.2.4

R402.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



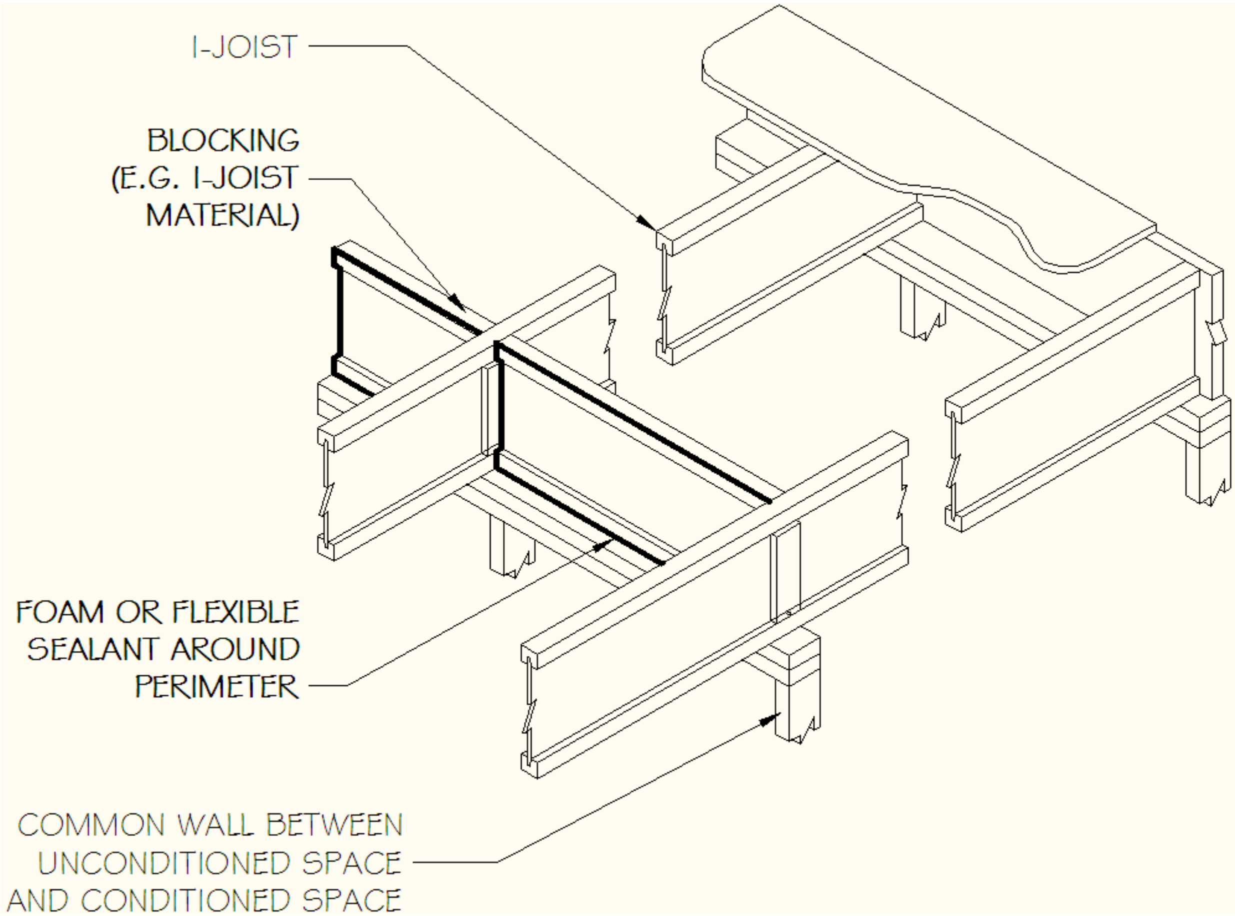
ISOMETRIC VIEW OF DIMENSIONAL LUMBER FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

R402.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



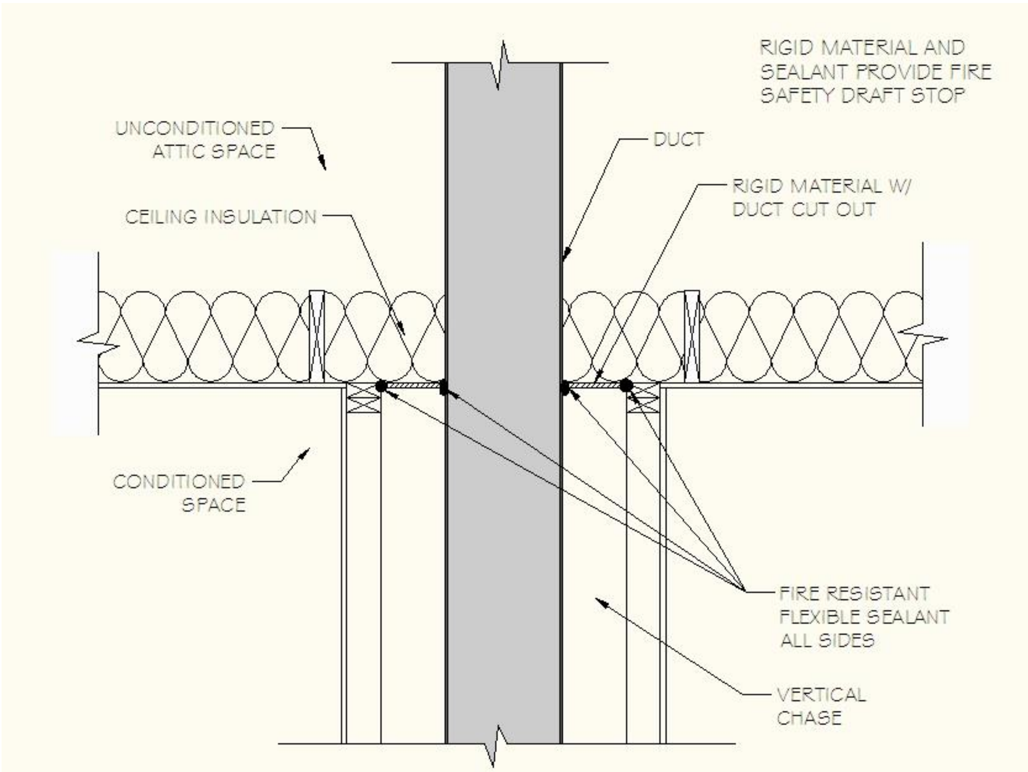
ISOMETRIC VIEW OF WOOD TRUSS FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

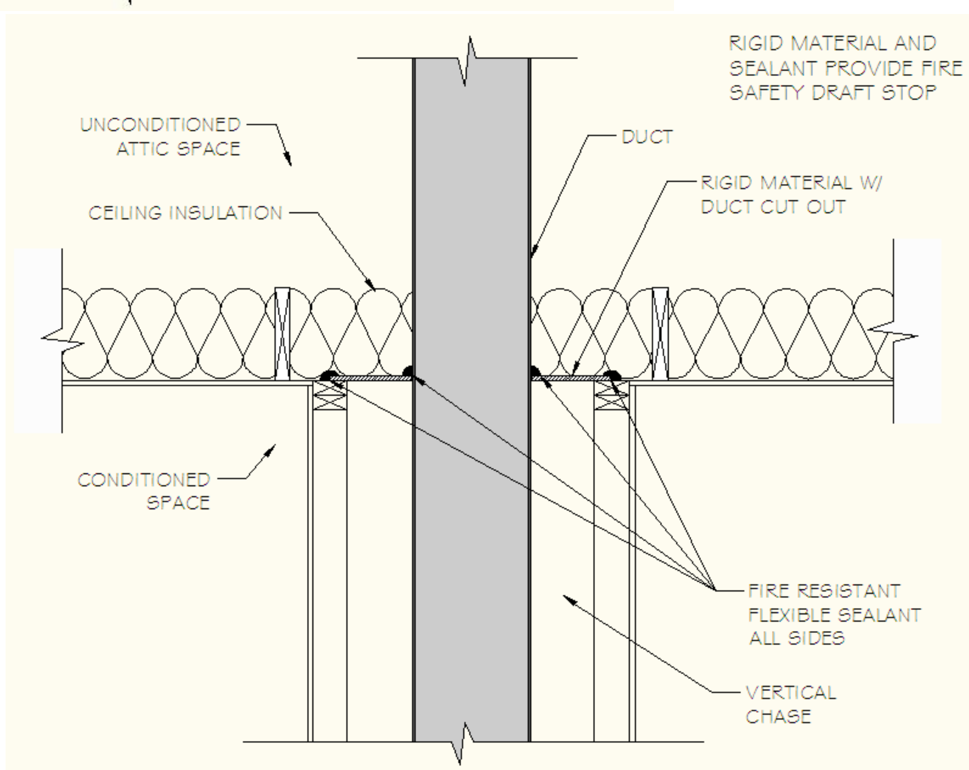
R402.4.1 Building thermal envelope. – 1. Block and seal floor/ceiling systems



ISOMETRIC VIEW OF I-JOIST FLOOR/CEILING SYSTEM ABOVE COMMON WALL BETWEEN UNCONDITIONED AND CONDITIONED SPACE

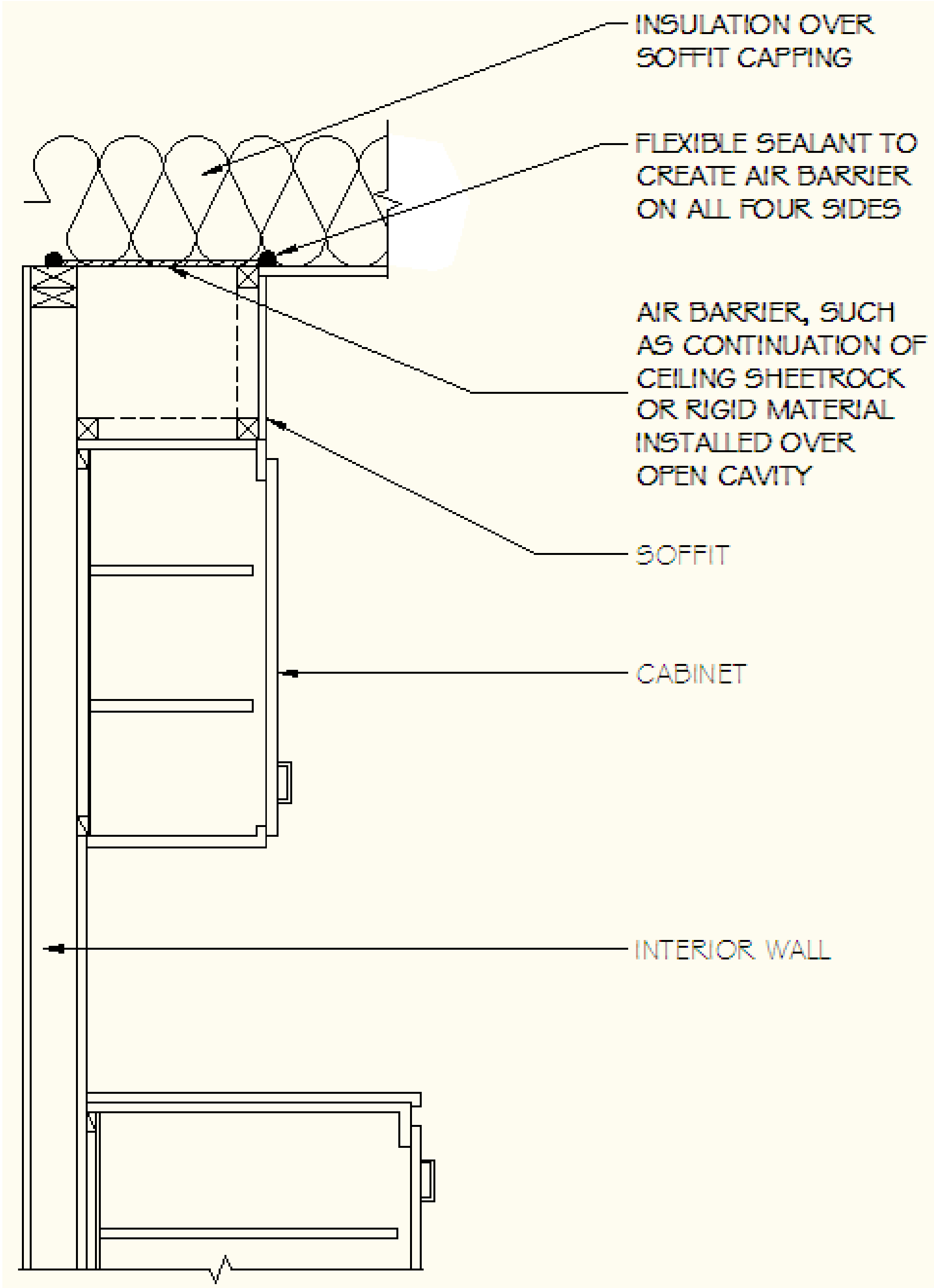
R402.4.1 Building thermal envelope – 2. Cap and seal shafts and chases





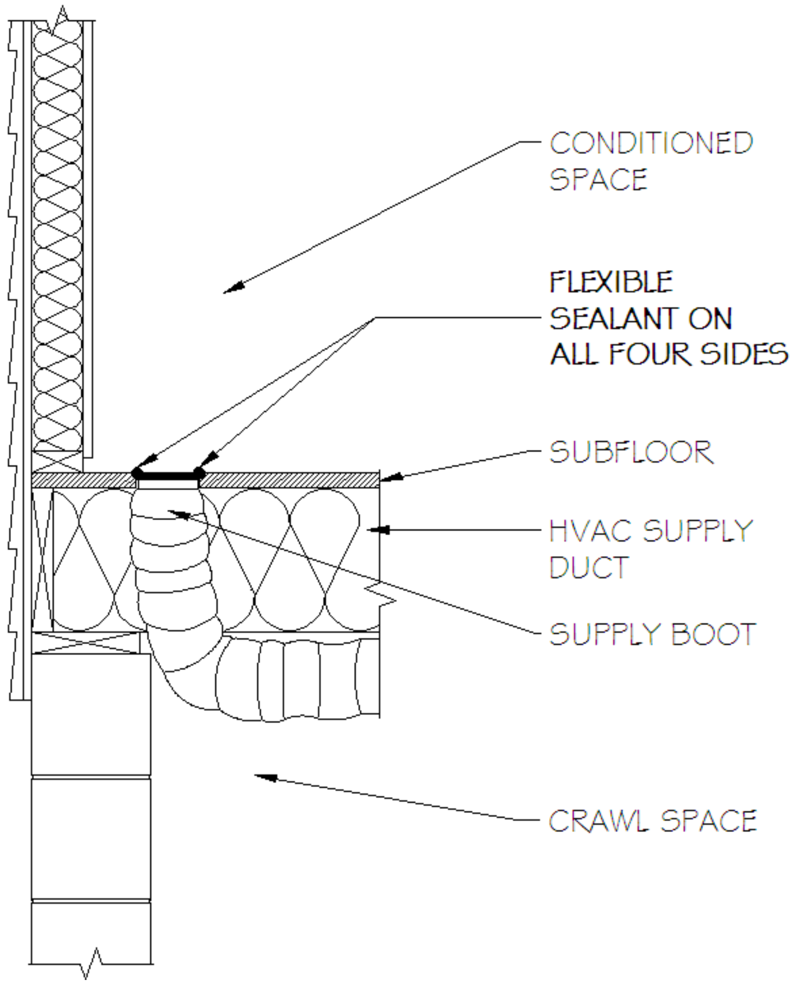
SECTION VIEWS OF DUCT PENETRATING INTO ATTIC

R402.4.1 Building thermal envelope. – 3. Cap and seal soffit or dropped ceiling



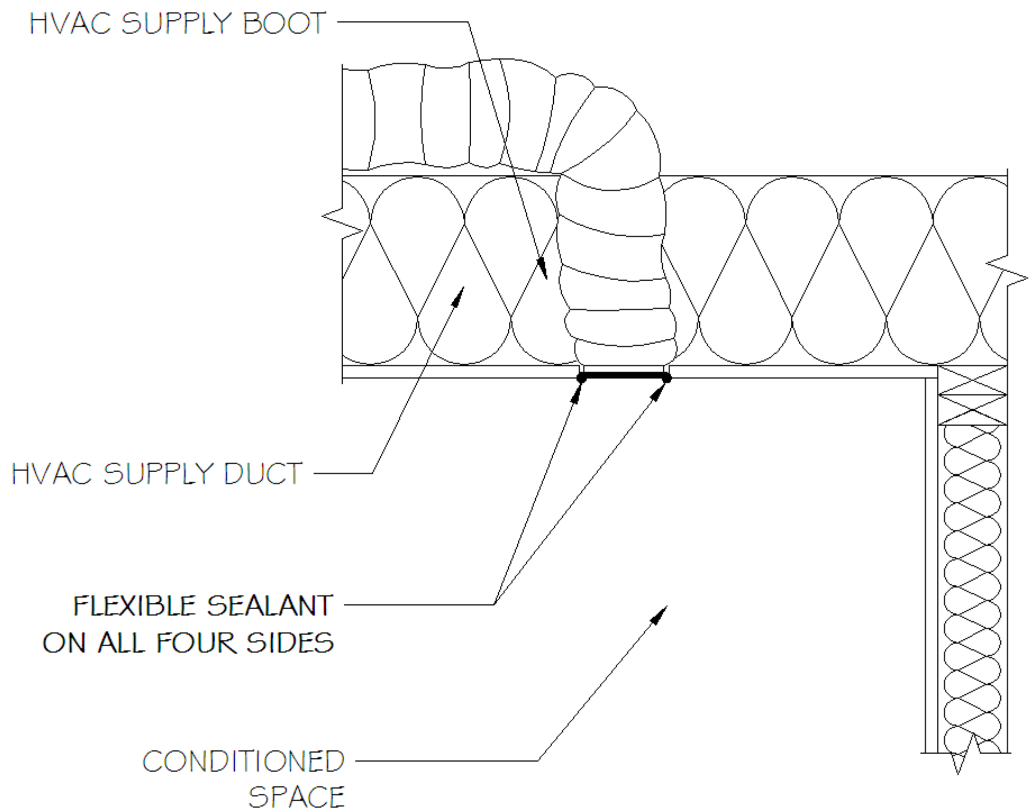
SECTION VIEW OF SOFFIT OVER CABINET

R402.4.1 Building thermal envelope. – 4. Seal HVAC boot penetration – floor



SECTION VIEW OF FLOOR HVAC BOOT PENETRATION

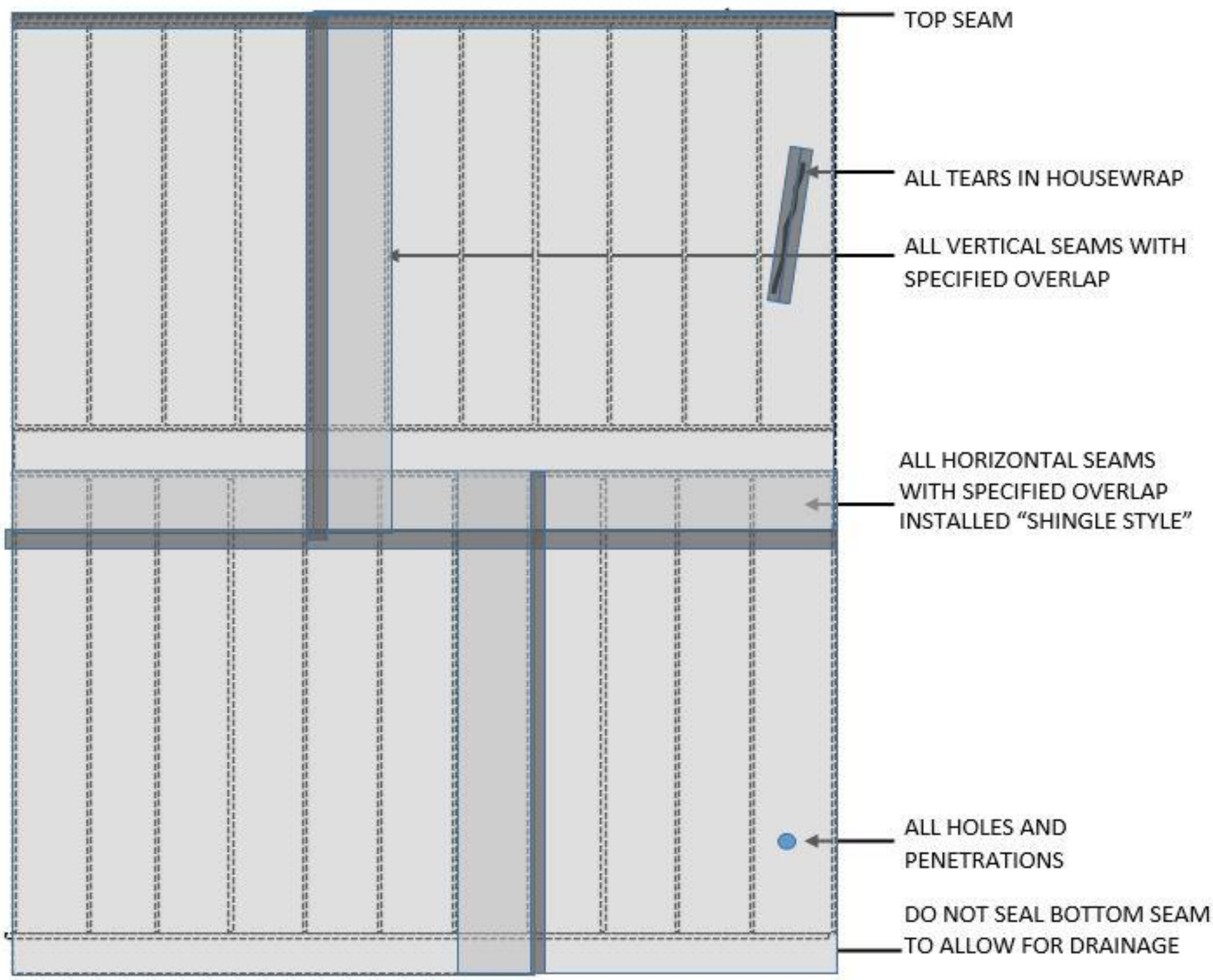
R402.4.1 Building thermal envelope. – 4. Seal HVAC boot penetration – ceiling



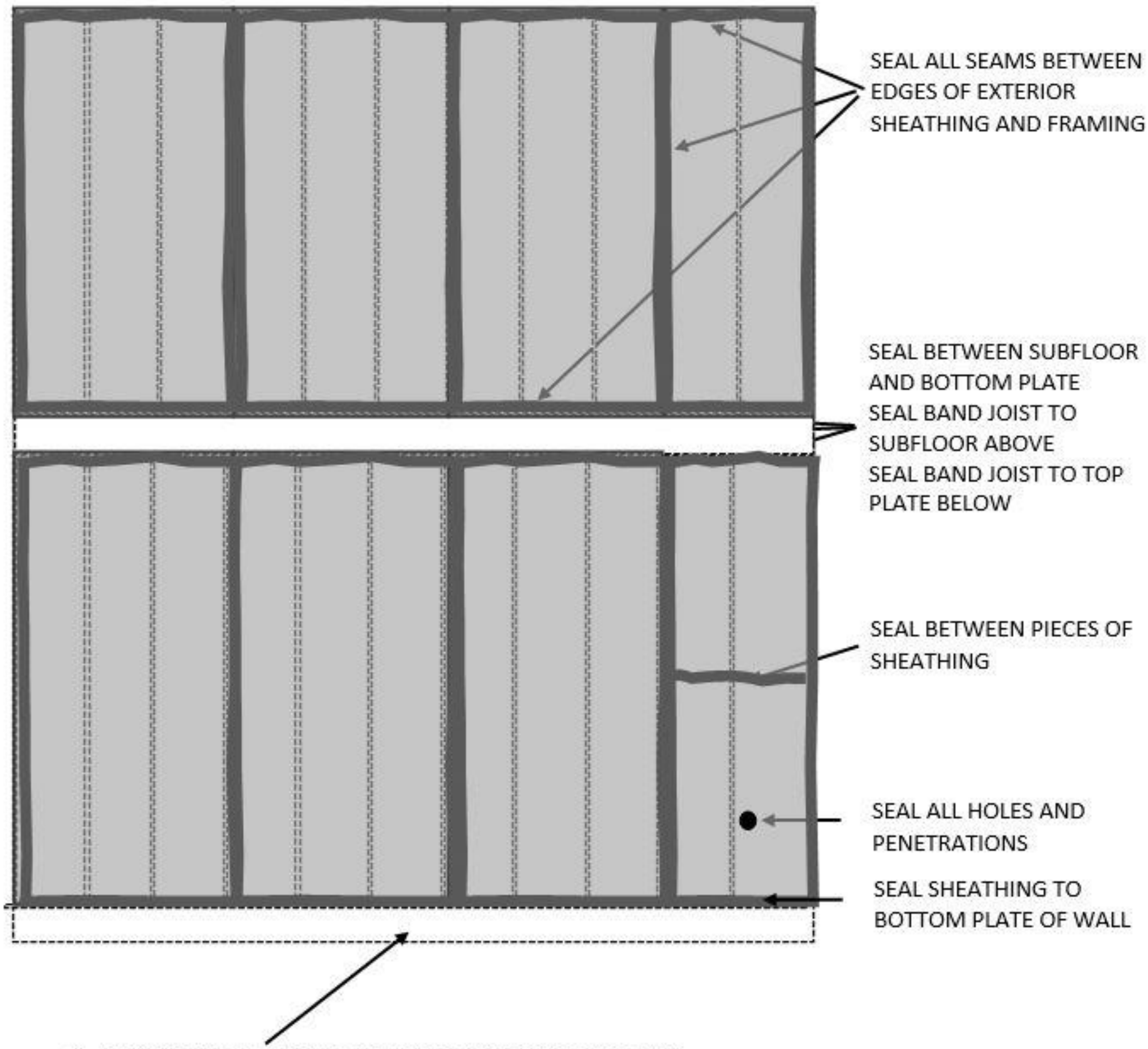
SECTION VIEW OF CEILING HVAC BOOT PENETRATION

R402.4.1 Building thermal envelope. – 5. Sealed exterior air barrier with housewrap

Follow manufacturer's instructions for sealing air barrier-rated housewrap, including choice of materials, to provide an exterior air barrier at the following locations:

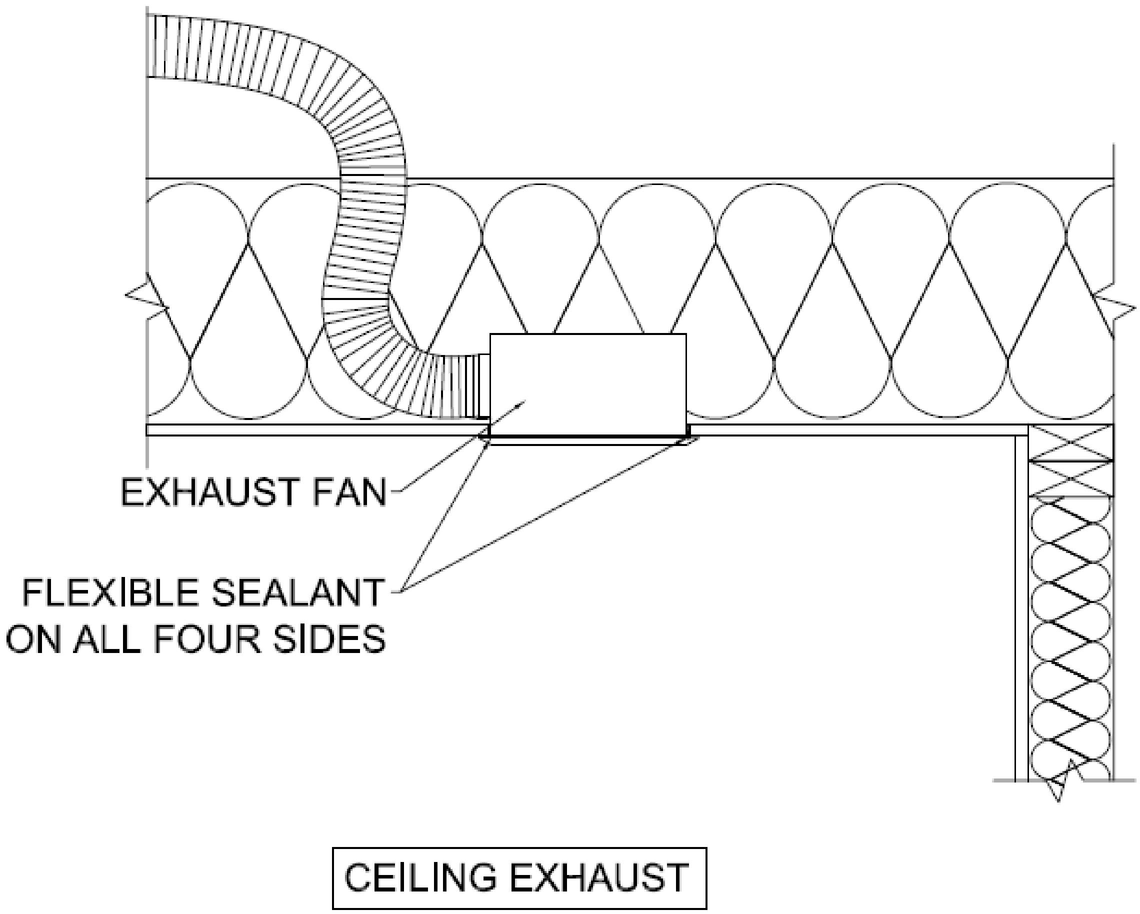


__**R402.4.1 Building thermal envelope. –** 5. Sealed exterior air barrier with sheathing__



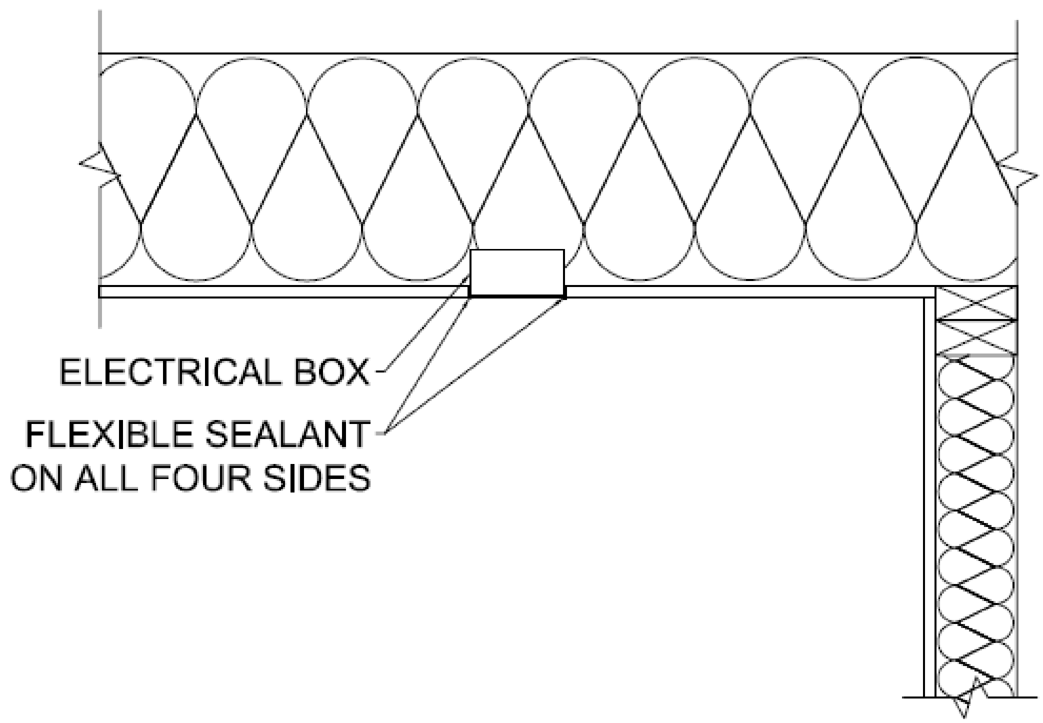
1) IF FIRST FLOOR IS SLAB-ON-GRADE, INSTALL SEAL SEALER UNDER BOTTOM PLATE OF EXTERIOR WALL.
2) IF FIRST FLOOR IS OVER UNCONDITIONED CRAWL SPACE OR BASEMENT, INSTALL SEAL SEALER UNDER BOTTOM PLATE AND SEAL SUBFLOOR TO BAND JOIST.
3) IF FIRST FLOOR IS OVER CONDITIONED BASEMENT OR CLOSED CRAWL SPACE WITH CRAWL SPACE WALL INSULATION BELOW, SEAL BETWEEN SUBFLOOR AND BOTTOM PLATE, SEAL BAND JOIST TO SUBFLOOR ABOVE, AND SEAL BAND JOIST TO TOP PLATE BELOW.

R402.4.2.1 Visual inspection option. – Table R402.4.2 Seal ceiling mechanical box penetrations



SECTION VIEW OF SEALING EXHAUST FAN BOXES

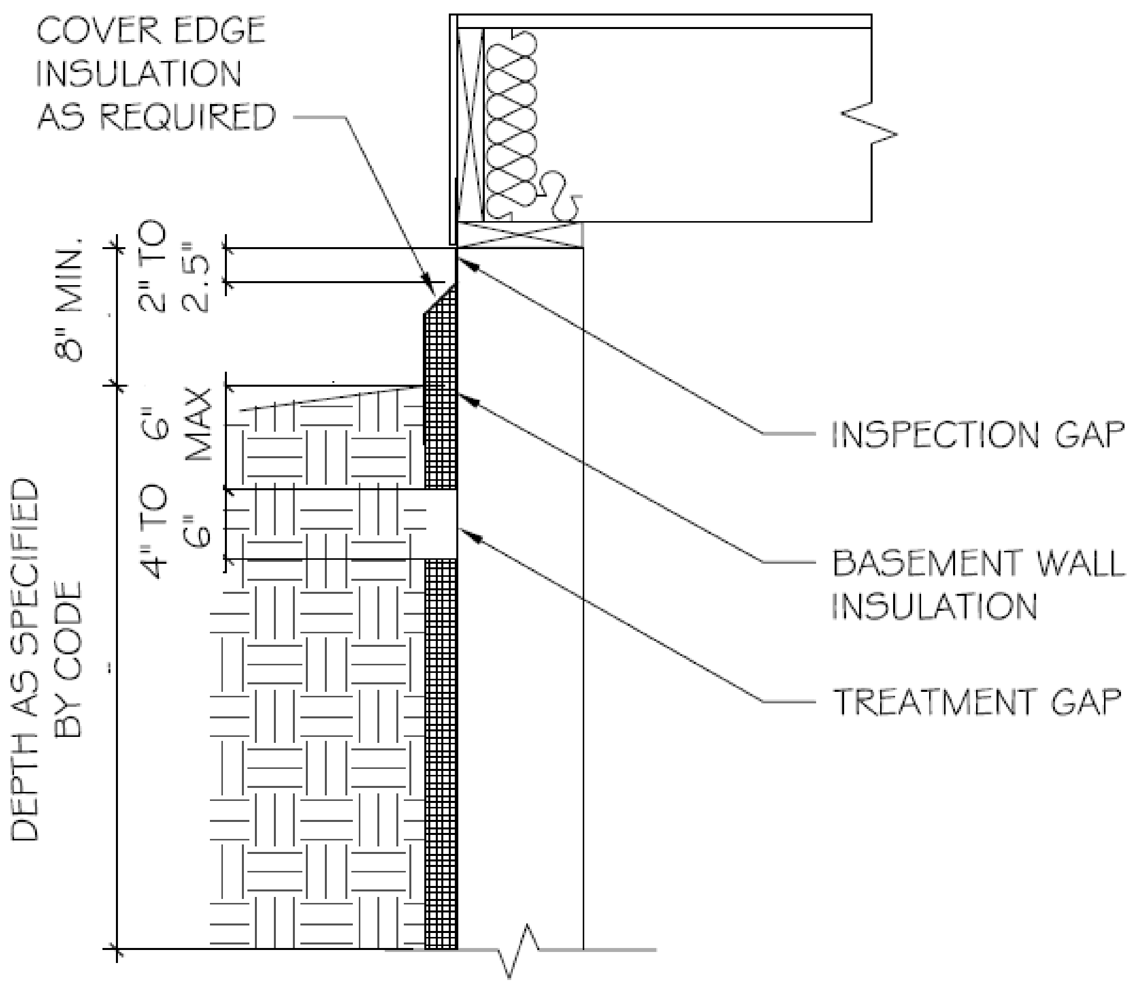
R402.4.2.1 Visual inspection option. - Table R402.4.2 Seal ceiling electrical box penetrations



CEILING ELECTRICAL BOX

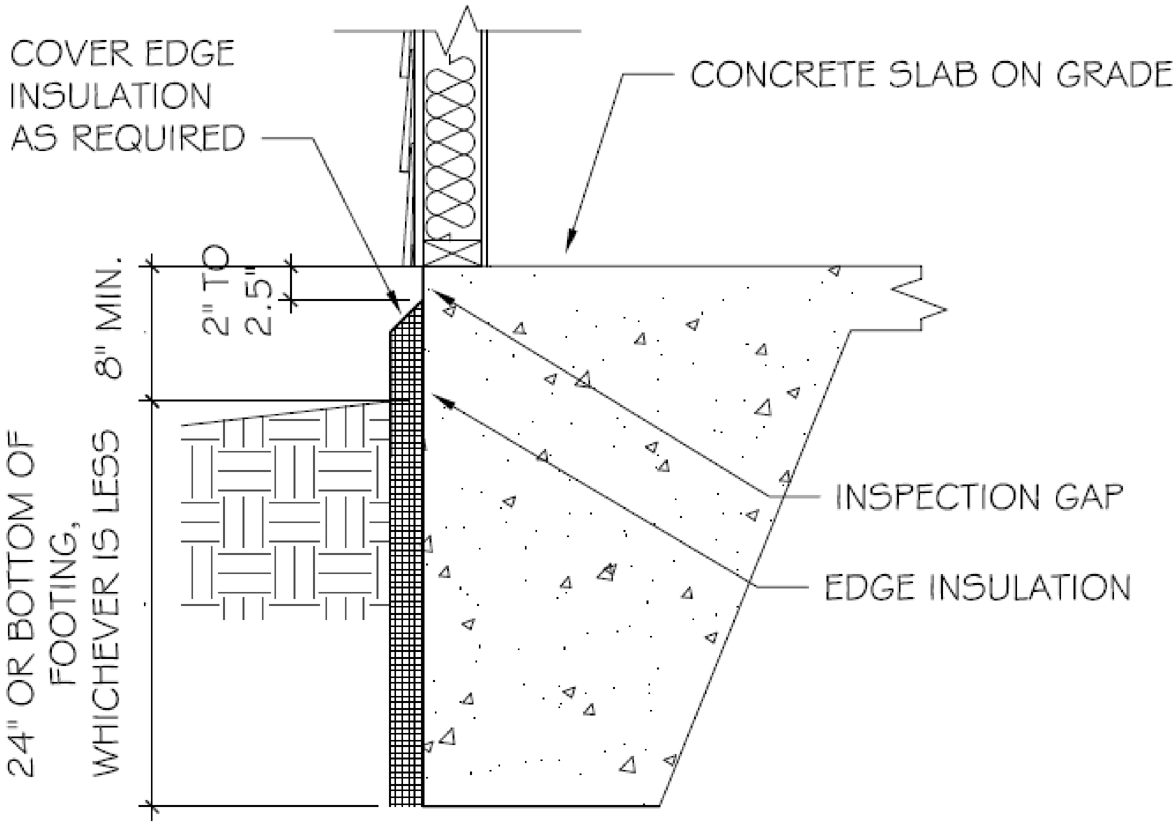
APPENDIX 2: FOAM PLASTIC DIAGRAMS

402.2.9 Basement walls with exterior foam insulation. Insulation illustrations (Includes detailing from R402.2.11)



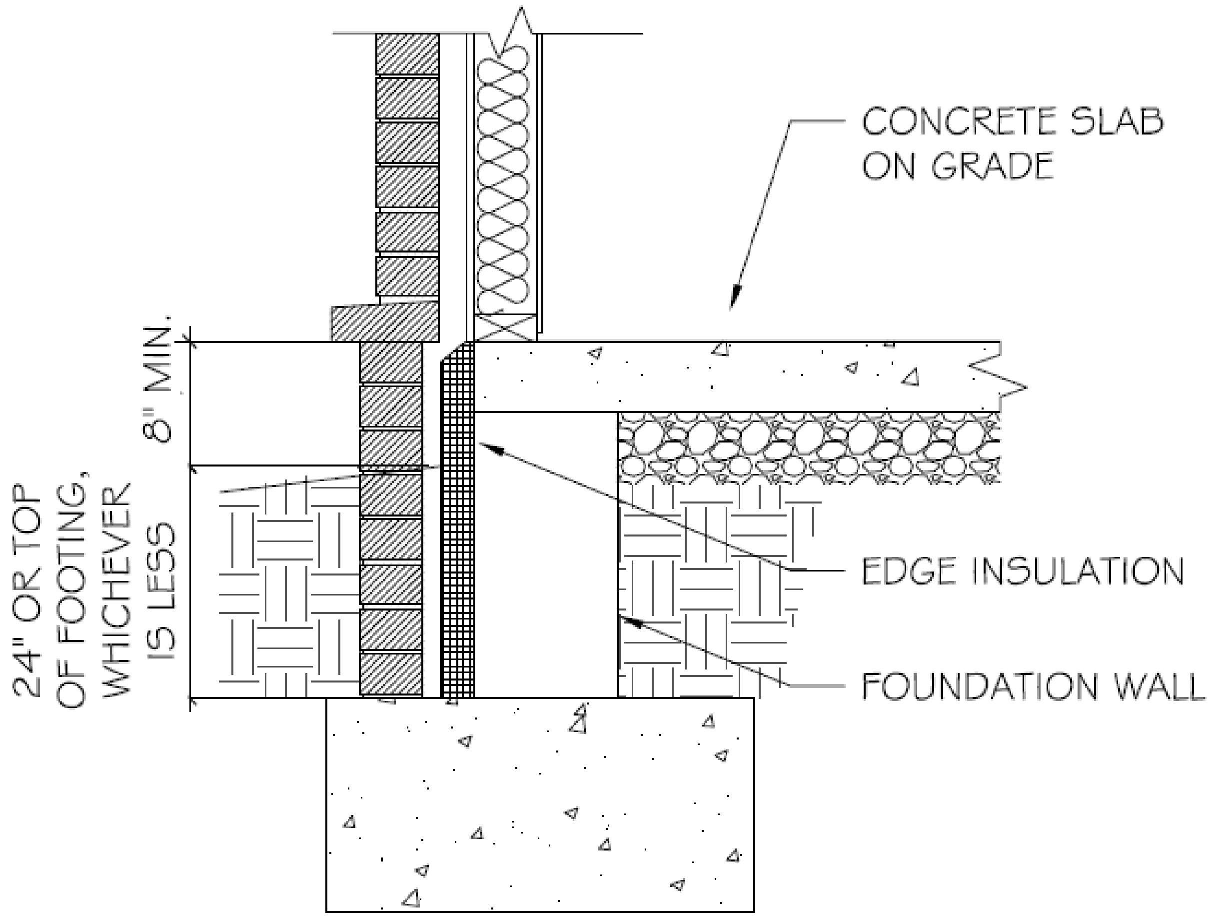
SECTION VIEW OF EXTERIOR FOAM INSULATION LOCATION FOR BASEMENT WALLS

402.2.10 Slab insulation details. Insulation illustrations



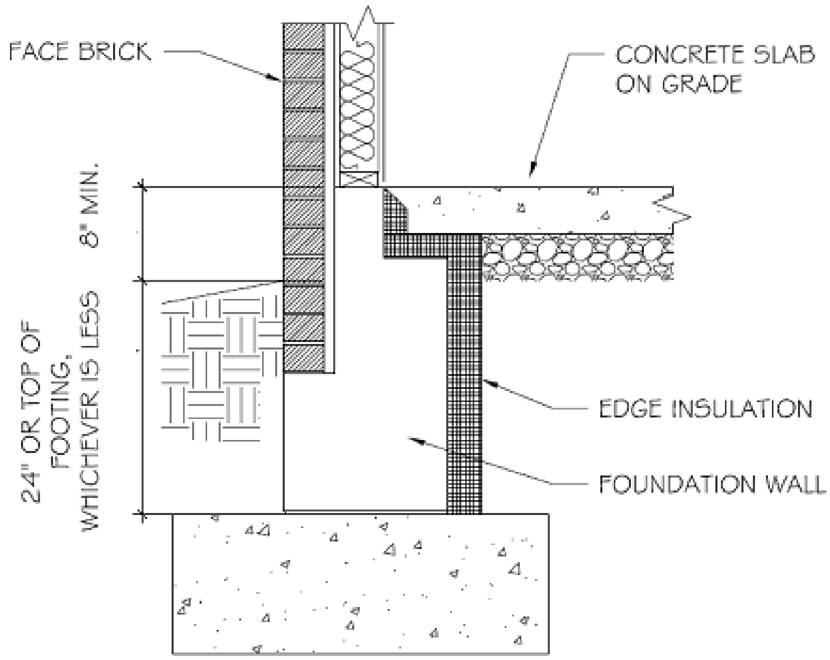
SECTION VIEW OF EDGE INSULATION FOR MONOLITHIC SLAB-ON-GRADE FLOORS

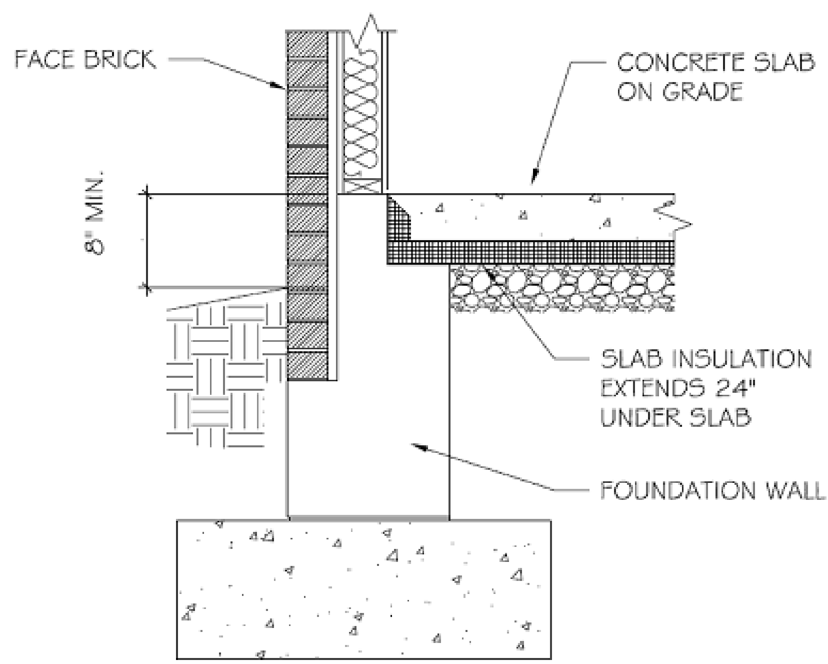
402.2.10 Slab insulation details. Insulation illustrations



EXAMPLE FOR SLAB EDGE INSULATION LOCATION
BEHIND BRICK, STONE, OR MASONRY FACING

402.2.10 Slab insulation details. Insulation illustrations





EXAMPLES FOR SLAB INSULATION LOCATION
FOR FLOATING SLAB WITH STEM WALL
(Options for brick facing are shown)

APPENDIX 3: SAMPLE WORKSHEETS FOR RESIDENTIAL AIR AND DUCT LEAKAGE TESTING

APPENDIX 3A

Air sealing: Visual inspection option (Section R402.4.2.1)

Sample Worksheet

R402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section R402.4.2.1 or R402.4.2.2:
R402.4.2.1 Visual inspection option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in R402.2.14 and enclosure and air sealing in R402.2.15 and air sealing in R402.4.1 are addressed and when the items listed in Table R402.4.2, 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 R402.4.2
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.
Ceiling penetrations	Ceiling electrical box penetrations and ceiling mechanical box penetrations shall be caulked, gasketed, or sealed at the penetration of the ceiling finish. See Appendix 1.2.4. **Exception**— ceiling electrical boxes and ceiling mechanical boxes not

	penetrating the building thermal envelope
Recessed lighting	Recessed light fixtures are air tight, IC rated, and sealed to drywall. **Exception**— fixtures in conditioned space.

Property Address:

R402.4.2.1 Visual Inspection Option

The inspection information including tester name, date, and contact shall be included on the certificate described in Section R401.3.

Signature Date

APPENDIX 3B

Air sealing: Testing option (Section R402.4.2.2)

Sample Worksheet

R402.4.2 Air sealing. Building envelope air tightness shall be demonstrated by Section R402.4.2.1 or R402.4.2.2:

R402.4.2.2 Testing option. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in R402.2.14 and enclosure and air sealing in R402.2.15 and air sealing in R402.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.30 CFM50/Square Foot of Surface Area (SFSA) or
2. Five (5) 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 E779-03. 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 R401.3.

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)**

APPENDIX 3C
Duct sealing. Duct air leakage test (Section R403.3.2 &Section R403.3.3)
Sample Worksheet

R403.3.2 Sealing (Mandatory Requirements). Ducts, air handlers, filter boxes, and building cavities used as ducts shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.

R403.3.3 Duct leakage (Prescriptive) and duct testing (Mandatory). Duct testing and duct leakage shall be verified by compliance with either Section R403.3.3.1 or R403.3.3.2. Duct testing shall be verified using one of the two following methods:

R403.3.3.1 Total Duct leakage. Total duct leakage less than or equal to 5 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, ventilation air duct(s) 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.

R403.3.3.2 Duct Leakage to the Outside. Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leaks. Duct leakage to the outside shall be 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, relative to the outside, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) 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 or as tight as possible.
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. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.
7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer's prescribed procedure.
8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure duct air leakage used in combination with a blower door. Typical steps are as follows:
    a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.

b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.
c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.
d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

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(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, 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 5 CFM25/100SF for the "Total duct leakage test or less than or equal to 4 CFM25/100SF for the "Duct leakage to the outside" test, then the HVAC system air tightness is acceptable.

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

Property Address: ____

Test Performed: Total duct leakage or Duct leakage to the outside **(circle one)**
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 CFM25x100/ 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)**

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 10-15% energy efficiency beyond the code minimums.

2. **Requirements**: Follow all sections of residential building provisions of the 2018 NCECC, except the following.
   a. Instead of using Table R402.1.2 in Section R402.1.2, use Table 4A shown below.

TABLE 4A
INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION U-FACTOR[b,j]	SKYLIGHT[b] U-FACTOR	GLAZED FENESTRATION SHGC [b,k]	CEILING R-VALUE[m]	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE[i]	FLOOR R-VALUE	BASEMENT [c,o] WALL R-VALUE	SLAB[d] R-VALUE	CRAWL SPACE[c] WALL R-VALUE
3	0.32	0.55	0.25	38 or 30 ci [l]	19, 13+5, or 15+3[h]	5/13 or 5/10ci	19	5/13[f]	**5**	5/13
4	0.32	0.55	0.25	38 or 30 ci [l]	19, 13+5, or 15+3[h]	5/13 or 5/10ci	19	10/15	10	10/15
5	0.32	0.55	(NR)	38 or 30 ci [l]	19, 13+5, or 15+3[h]	13/17 or 13/12.5 ci	30[g]	10/15	10	10/19

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.

c. "10/15" means R-10 continuous insulated sheathing on the interior or exterior of the home or R-15 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 24 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 2) 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 Section 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 Section 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 to either 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 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.

b. Instead of using Table R402.1.4 in Section R402.1.4, use Table 4B to find the maximum U-factors for building components.

TABLE 4B
EQUIVALENT U-FACTORS[a]

CLIMATE ZONE	FENESTRATION U-FACTOR [d]	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR[b]	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR[c]	CRAWL SPACE WALL U-FACTOR
3	0.32	0.55	0.030	0.061	0.141	0.047	0.091	0.136
4	0.32	0.55	0.030	0.061	0.141	0.047	0.059	0.065
5	0.32	0.55	0.030	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.

c. For compliance with Section R402.4 Air leakage control (Mandatory Requirements), Sections R402.4.1 (Building thermal envelope) and R402.4.2.2 (Testing option) must be followed, with the maximum leakage rate shown below. Section R402.4.2.1 (Visual inspection option) cannot be used to show compliance.
   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 R403.3.3 use the following:
   1. **R403.3.3.1 Total Duct Leakage**. Total duct leakage less than or equal to 4 CFM (113 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.
   2. **R403.3.3.2 Duct Leakage to the Outside.** Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 3 CFM (85 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, relative to the outside, including the manufacturer's air handler enclosure.

e. For compliance with Section R404.1 (Lighting equipment), the home must comply with the following:

Not less than 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 90 percent of the permanently installed lighting fixtures shall contain only high-efficacy lamps.

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 (Notes correlate to Table R402.1.2)**				**Proposed Project Values**
Climate Zone	**3**	**4**	**5**	-
Fenestration U-Factor [b,j]	**0.32**	**0.32**	**0.32**	-
Skylight U-Factor [b]	0.55	0.55	0.55	-
Glazed Fenestration SHGC [b,k]	**0.25**	**0.25**	(NR)	-
Ceiling R-value [m]	38 or 30 ci [l]	38 or 30 ci [l]	38 or 30 ci [l]	-
Wood Frame Wall R-value [h]	19, 13+5, or 15+3	19, 13+5, or 15+3	19, 13+5, or 15+3	-
Mass Wall R-value [i]	5/13 or 5/10ci	5/13 or 5/10ci	13/17 or 13/12.5 ci	-
Floor R-value	19	19	30[g]	-
Basement Wall R-value [c,o]	5 /13[f]	10/15	10/15	-
Slab R-value and Depth [d]	5	10	10	-
Crawl Space Wall R-value [c]	5/13	10/15	10/19	-
-	** Note: ci = continuous insulation*			
High Efficacy Lighting	-			
% of lighting that is high efficacy according to R404.1. (90% required)	-			
Building Air Leakage	-			
Building Air Leakage Test according to R402.4.2.2 (check box). Show test value:	-			
ACH50 [Target: 4.0], or	-			
CFM50/SFSA [Target: 0.24]	-			
Name of Tester / Company:	-			
Date: Phone:	-			
Duct Insulation and Sealing	-			
Insulation Value	R-			
Duct Leakage Test Result (Sect. R403.3.3)	☐ Total duct leakage or ☐ Duct leakage to the exterior			
(CFM25 Total/100SF) [Target: 4 Total/ 3 To exterior]	-			
Name of Tester or Company:	-			
Date: Phone:	-			

4D:

SAMPLE WORKSHEETS FOR RESIDENTIAL AIR AND DUCT LEAKAGE TESTING

4D.1
Air sealing: Testing (Section R402.4.2.2)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

Air sealing. Building envelope air tightness shall be demonstrated by Section R402.4.2.2:

Air sealing: Testing (Section R402.4.2.2)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

N1102.4.2.2 Testing. Building envelope tightness shall be considered acceptable when items providing insulation enclosure in R402.2.14 and enclosure and air sealing in R402.2.15 and air sealing in R402.4.1 are addressed and when tested air leakage is less than or equal to one of the two following performance measurements:

1. 0.24 CFM50 (6.8 L/min)/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 0.2 inches water gauge (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 E779-03. 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 R401.3.

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 **[0.24 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 CF/Hour50 and record = ______________. Then calculate the total conditioned volume of the home and record = ________________cubic feet. Divide the CF/Hour50 by the total volume and record the result = _____________________ ACH50. If the result is less than or equal to **[4 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.2

Duct sealing. Duct air leakage test (Section R403.3.3)
Sample Worksheet for Alternative Residential Energy Code for Higher Efficiency

R403.3.3 Duct leakage (Prescriptive) and Duct Testing (Mandatory). Duct testing and duct leakage shall be verified by compliance with either Section R403.3.3.1 or R403.3.3.2. Duct 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(s) has been certified by the manufacturer to be capable of conducting tests in accordance with ASTM E1554-07.

The duct leakage information, including duct leakage test selected and result, tester name, date, and contact information, shall be included on the certificate described in Section R401.3.

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 CFM25/100SF for the "Total duct leakage test or less than or equal to 3 CFM25/100SF for the 'Duct leakage to the outside" test, then the HVAC system air tightness is acceptable.

Exceptions to testing requirements:

1. Duct systems or portions thereof inside the building thermal envelope shall not be required to be leak tested.

2. Installation of a partial system as part of replacement, renovation or addition does not require a duct leakage test.

R403.3.3.1 Total Duct Leakage. Total duct leakage less than or equal to 4 CFM (113 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, ventilation air duct(s) 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.

R403.3.3.2 Duct Leakage to the Outside. Conduct the test using fan pressurization of distribution system and building at a fixed reference pressure for combined supply and return leak. Duct leakage to the outside shall be less than or equal to 3 CFM (85 L/min) per 100 ft2 (9.29 m2) 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, relative to the outside, including the manufacturer's air handler enclosure.

During testing:

1. Block, if present, the ventilation air duct(s) 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 or as tight as possible.

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. Open all interconnecting doors in the building, close dampers for fireplaces and other operable dampers.

7. Set up an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door, following the manufacturer's prescribed procedure.

8. Specific instructions from the duct testing equipment manufacturer shall be followed to reach duct test pressure and measure

duct air leakage used in combination with a blower door. Typical steps are as follows:

a. Depressurize the ductwork system to 25 Pa using the measurement hose in Step 5 above.

b. Depressurize the house to 25 Pa using an envelope air moving/ flow-regulating/ flow measurement assembly, such as a blower door.

c. Correct the duct pressure to measure 0 Pa of pressure differential between the house and the ductwork system.

d. Read the CFM of duct leakage using the procedures for the specific equipment being used. (Note that most automatically calculating pressure gauges cannot compute the CFM25 automatically with a duct-to-house difference in pressure of 0 Pa, so the gauge setting should be set to read CFM instead of CFM25).

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 = ____ CFM25/100 SF
(e.g. 50 CFM25 x 100/ 2,000 CFA = 2.5 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)**