BURIED DUCTWORK

Proposed language for
R403.3 (Revised)

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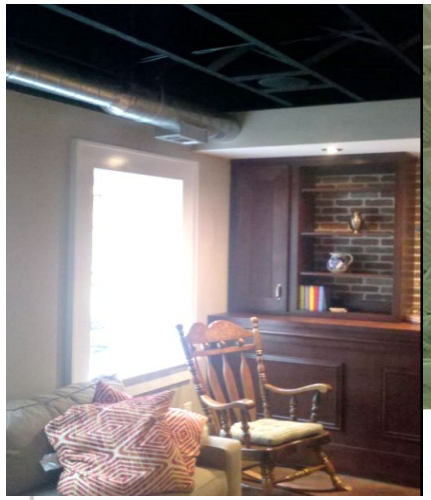
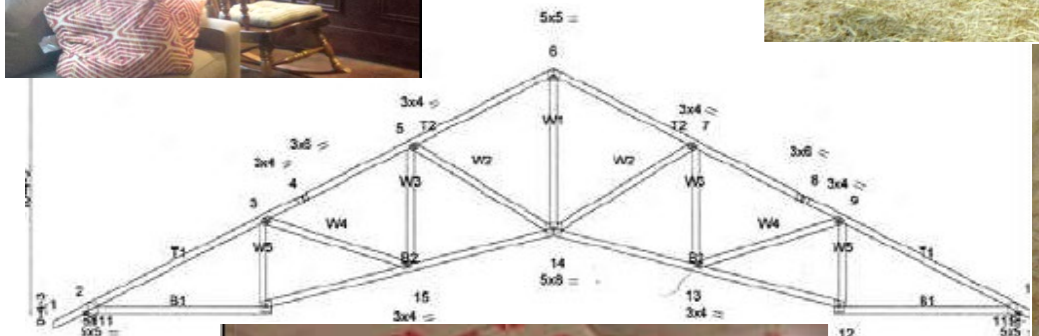
Duct Design

- Ways to locate ductwork inside conditioned space





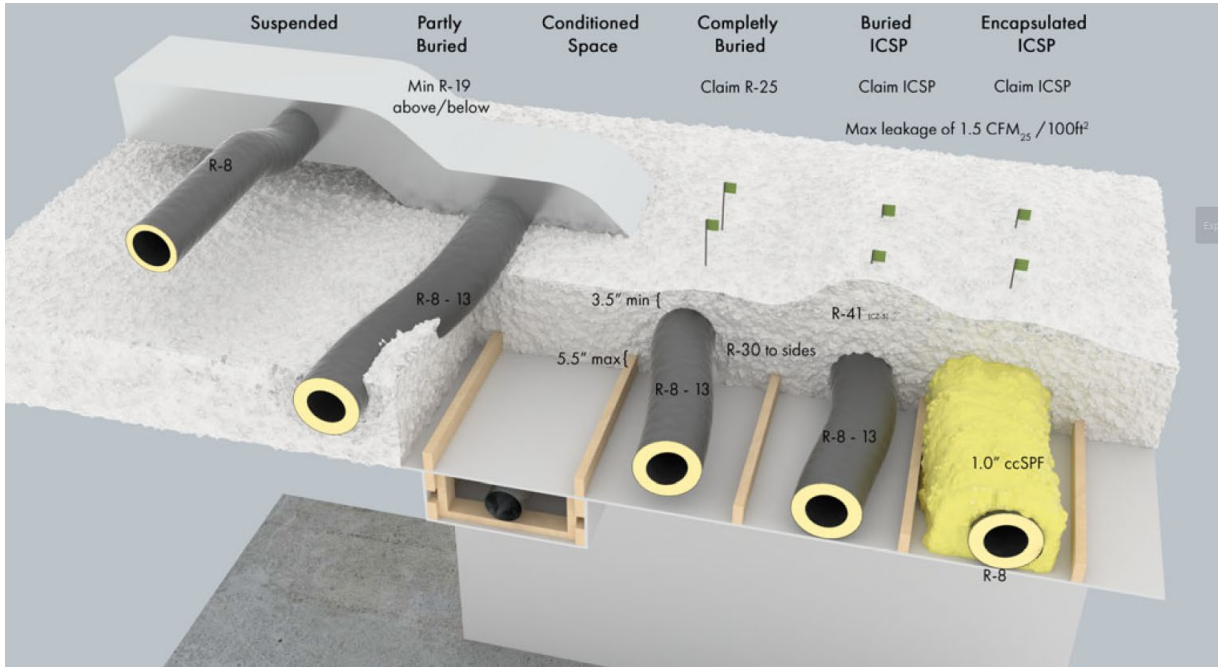
R-8 Ducts Buried under Attic Insulation in Hot/Humid Climates (0A, 1A, 2A & 3A)

Technical Summary, March 2025

Not for distribution outside Buried Ducts Trials Technical Team

Please wait for full technical report from FSEC/Owens Corning

What type of buried duct?



https://www.phrc.psu.edu/assets/docs/Webinars/Ductwork_in_Attics_Handouts.pdf

What Type of Buried Duct?

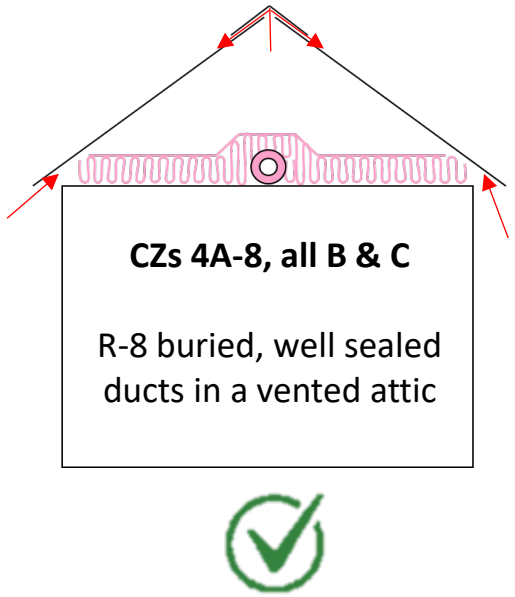
- Partially Buried – No, doesn't minimize ΔT in ducts
- Completely Buried – Yes (%), for jumper ducts, registers near wall (no raised heel), etc
  - Can claim R-25 effective R-value
  - 3.5" minimum insulation over the duct
- Deeply Buried – Yes, minimizes ΔT in supply & return ducts
  - Ducts thermally broken by attic thermal requirement code R-30, 38, 49 (example, R-38 = R-8 duct + R-30 loosefill mounded over duct)
- Encapsulated – No

Deeply Buried Ducts → Focus of Efficacy Testing

1) Provided the most potential for condensation during efficacy testing
2) Validate that deeply buried ducts would provide a result that was considered "Ducts in Conditioned Space"

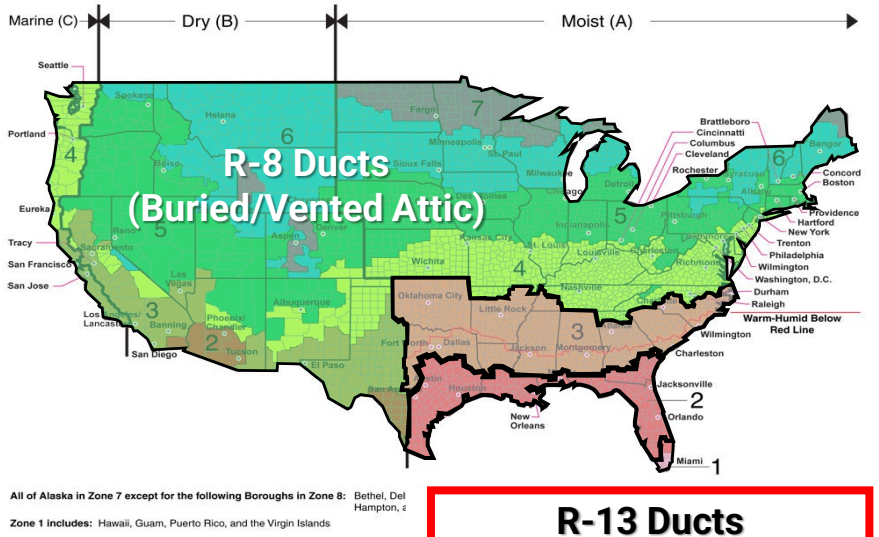
Problem Statement

- **Problem Statement (July 2020):** Burying ducts in a vented attic in CZs 1A–3A requires the use of R-13 supply ductwork or encapsulated ducts. This is a problem as;
  1) R-13 ducts are not commercially available / R-13 ducts not highly compatible with accessories.
  2) Building R-13 ductwork onsite (R-8 pulled over R-6) adds $1,500 (material/labor) and extended time.
  3) Encapsulating ducts is cost prohibitive.

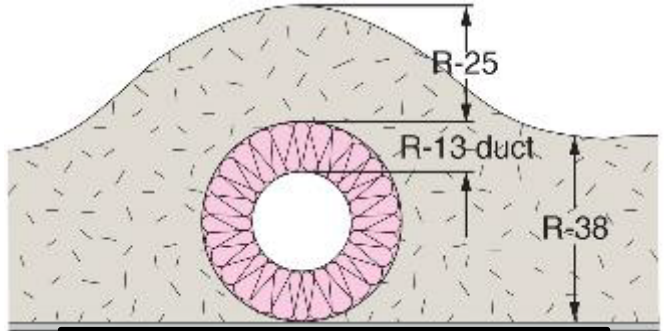


CZs 4A-8, all B & C

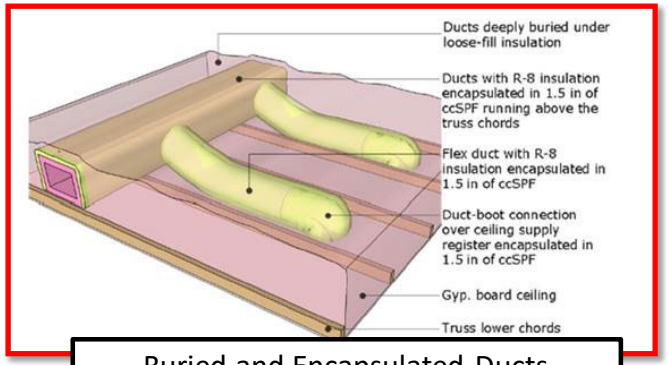
R-8 buried, well sealed ducts in a vented attic



R-13 Ducts (Buried/Vented Attic)



R-13 Ducts Buried



Buried and Encapsulated Ducts

Efficacy

EFFICACY TESTING → Initial Hypothesis: R-8 ducts can be buried beneath R-22/30/41 of attic insulation in Climates Zones 1A, 2A & 3A and operate without the risk of damage from condensation.

- **Experimental Procedures (Spring 2021 to Fall 2024)**
  1) Efficacy of R-8 ducts buried in a Vented Attic to R-38
  2) Efficacy of R-8 ducts buried in an Unvented Attic to R-38
     - with Vapor Diffusion Vent @ Roof Ridge to address moisture
     - with supply air added to attic to address moisture (50cfm or supply air per 1,000 sf of attic floor)
- **Where?**
  - UCF/FSEC flexible roof test facility in Cocoa, FL (Climate Zone 2A)
  - Additional test houses in FL (CZs 1A, 2A) & TX (CZs 2A, 3A)

Figure 1: South side of FRF with roof as configured for original project study period and first extension.

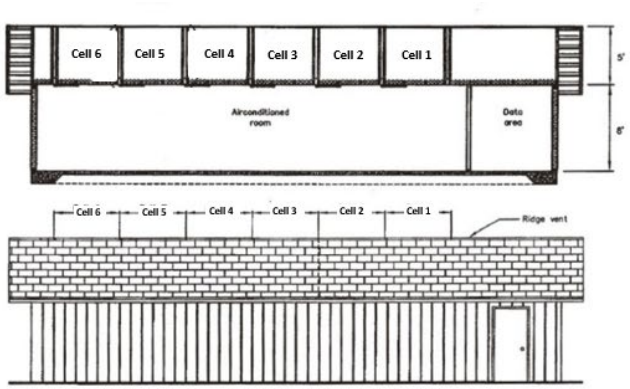


Figure 2: FRF divided attic cell design.

- **Baseline Testing Details**
  - T&RH monitoring (outside, plenum, ducts closest to plenum (top, bottom and side), boots and attic (various vertical locations))
  - Duct system total leakage at 4% or better (2% or better was achieved in all trials with mastic ACCA standard)
  - HVAC temp and runtime set points at traditional and stressed scenarios (78˚/75˚F typical design set points vs 68˚/65˚F stressed set points)
  - Reflective Roof (White Metal) and Traditional Dark Asphalt
    - White metal having better performance in reflecting solar heat gain than Radiant Barrier sheathing, reduces the attic temperatures and reduces the potential for drying of ducts if condensation occurs. Dark asphalt roofs keep attic hotter and will perform better in drying condensation on ducts if occurring.
- **Extraordinary Conditions also Tested**
  - Various insulated boots
  - Over-insulated with loosefill / under-insulated with loosefill / Compressed ducts
  - Impact of duct air leakage (small & large leaks impact to condensation)

4 Possible Outcomes for Success

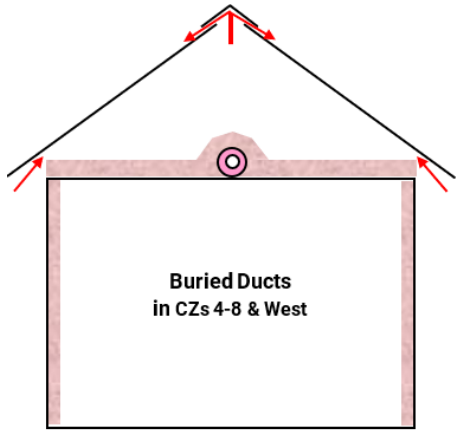
- **Can we bury R-8 ducts in a Vented Attic in CZs 1A – 3A? Address Condensation on Ducts?**

- **Pivot 1 → Unvented Attic + Vapor Diffusion Vent**
  - Unventing of the Attic should block significant amounts of air carried moisture, reducing the moisture content in the attic and minimizing condensation potential on ducts buried under insulation.
  - The Vapor Diffusion Vent will provide an air barrier at the roof ridge but the primary benefit being that it provides a safety valve for interior/exterior created moisture to dry to the outside at the point where moisture accumulates in the attic (within 24" of the ridge)

- **Pivot 2 → Unvented Attic + Vapor Diffusion Vent + Supply Air**
  - Adding a small amount of supply air to the attic should be sufficient to dry the attic when the HVAC system is operational. The cost of adding 50cfm of supply air is very low during construction, <$100. The energy impact is very small.

- **Pivot 3 → Unvented Attic + Vapor Diffusion Vent + Dehumidification**
  - Dehumidification is another option but that is a last pivot as dehumidification is costly >$1,000 and must be maintained.

Testing Outcomes – Stage 1 Test

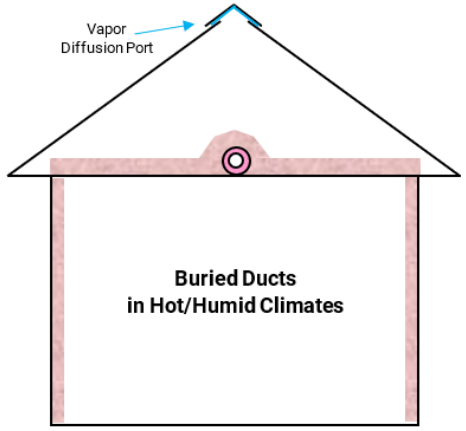


Initial Efficacy Test

- Vented Attic
- R-38 Attic
- R-8 Buried under R-30

- **Timing – Spring/Summer 2021**
- **Experimental Procedure –**
  - R-8 ducts buried under R-30 loosefill insulation (meeting R-38 thermal requirement) in a Vented Attic
- **Outcomes –**
  - Buried ducts under the white metal "cool attic" experienced somewhat higher duct outer jacket moisture potential.
  - Some periods where the top of duct measurement achieved 100% RH
  - CZ 2A has 2 to 2.5 months in the summer where the daily RH and dew point stays high throughout the 24-hour day. The vented attic RH is consistent with outside RH. The primary concerns comes is at nighttime. The solar heating load is removed and reduces the ability to dry the ducts if/when condensation does occur. Occupants in this climate will continue to run systems throughout the night with lower temp set points in the evening forcing the system to operate, but with less drying potential in the attic due to the elimination of solar heat gain.
  - Determined that target/safe RH should be less than 80% RH at top of duct (daily average) to address condensation and ability to dry.
- **Next Steps –**
  - Pivot to next option

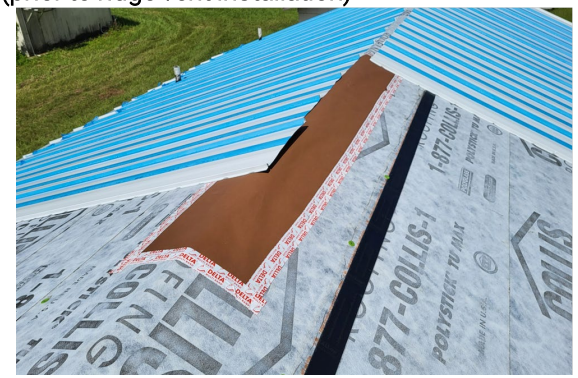
Testing Outcomes – Stage 2 Test



Secondary Option
- *(change) Unvented Attic*
- *(add) Vapor Diffusion Vent*
- R-38 Attic
- R-8 Buried under R-30

- **Timing – Late Summer 2021 to Summer 2022**
- **Experimental Procedure –**
  - R-8 ducts buried under R-30 loosefill insulation (meeting R-38 thermal requirement) in an **unvented attic**
  - Install **vapor diffusion vent at ridge vent** to allow attic and occupant created moisture to escape (meeting IRC R806.5.2, air barrier, roof WRB but vapor open)
  - Evaluated methods to un-vent the attic
    1) Un-vent via soffits → OSB/Fiber Cement type & aluminum (with and without caulk)
    2) Blocking between trusses → top plate & roof sheathing (with and without can foam)

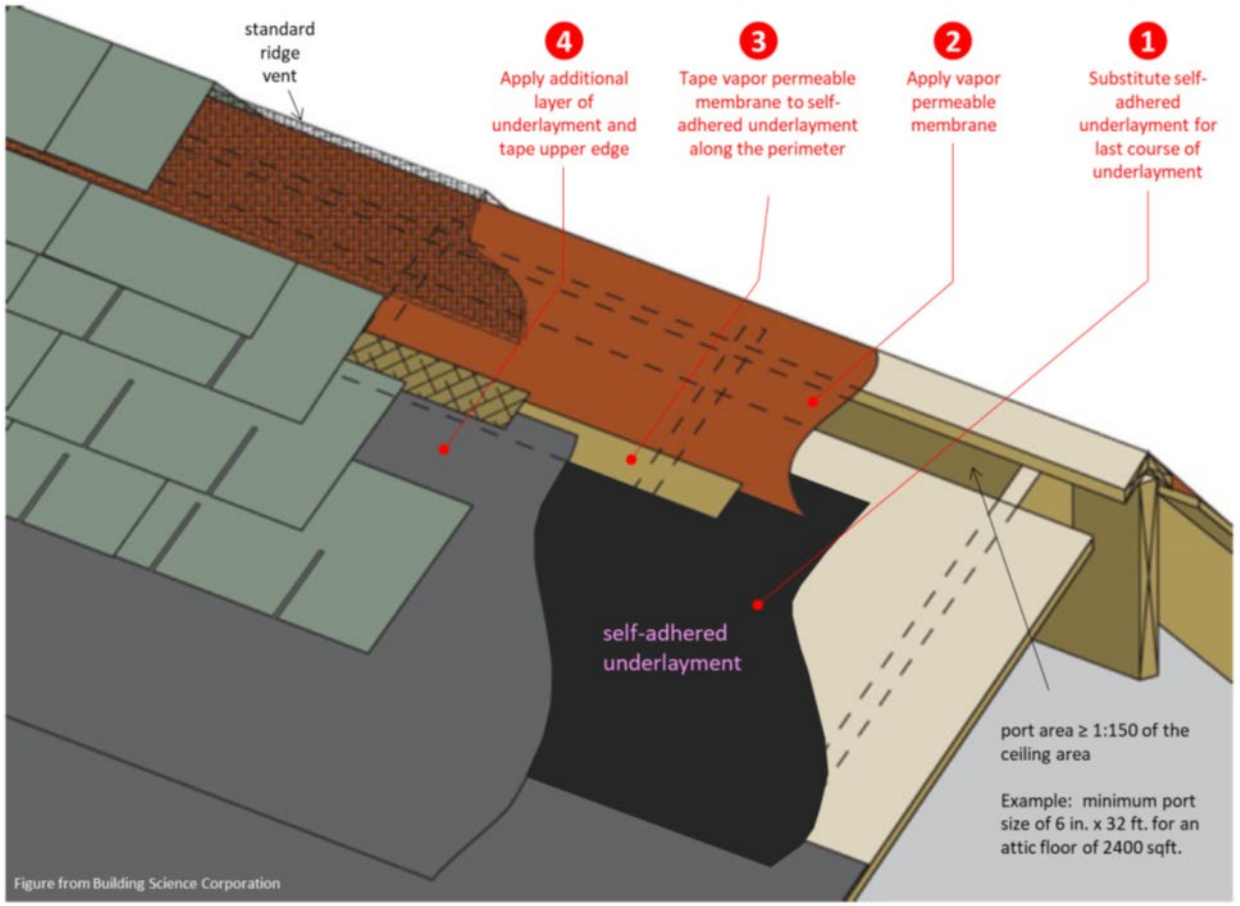
Vapor Diffusion Vent @ Ridge (prior to ridge vent installation)



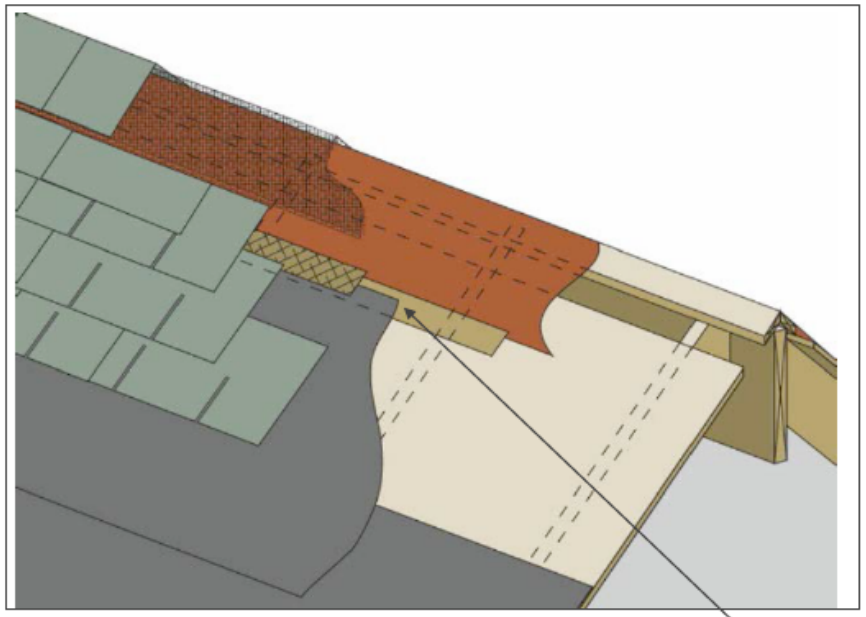
- **Outcomes –**
  - The un-venting of the attic immediately showed positive impact to lower the attic RH by 10-15%. This action also heats up the attic by a few degrees which benefits the ability for any condensation created on the duct to dry.
  - Construction practices to un-vent the attic varied, (1) truss blocking (best) and (2) hard stock type soffit (OSB or FC) performed well. Aluminum soffit (embedded in caulk) met requirements minimizing RH but Aluminum soffit (not embedded in caulk) did not perform as well to block air carried RH into the attic.
  - Vapor Diffusion Vent showed its ability to "assist" in drying the interior occupant created moisture load *(see NREL paper)*
  - Performed OK with setpoint at 75F and under both black asphalt roofs.
  - Duct condensation risk still seen in a stressed situation (setpoint @ 65-68F and under the white reflective roof. White reflective roofs cool the attic and provide less drying potential).
- **Next Steps –** Pivot to next option as this is still risky in CZs 1A & 2A. Unknown/No testing in CZ 3A.

Vapor Diffusion Vent (Hot/Humid Climates, 0A – 3A)

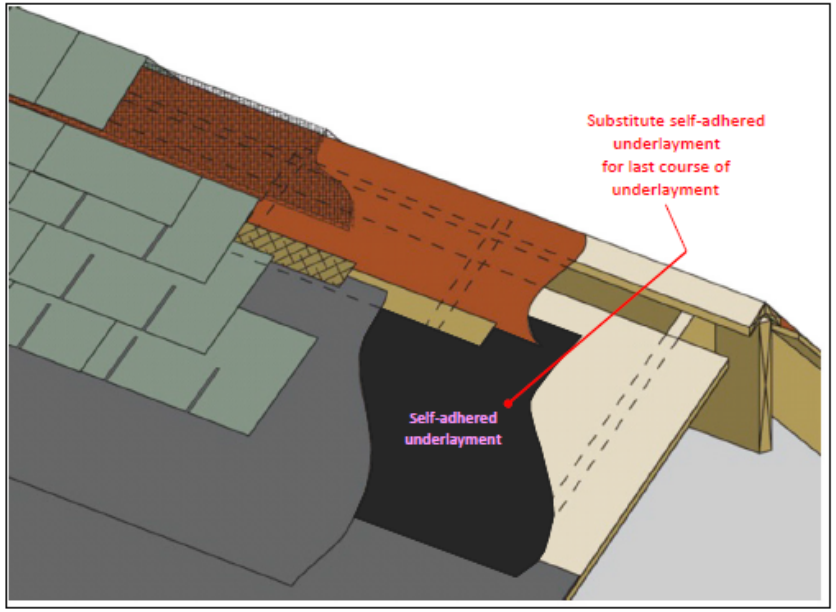
The diffusion vent material under ridge vents allows moisture out of the attic while eliminating the free movement of air.

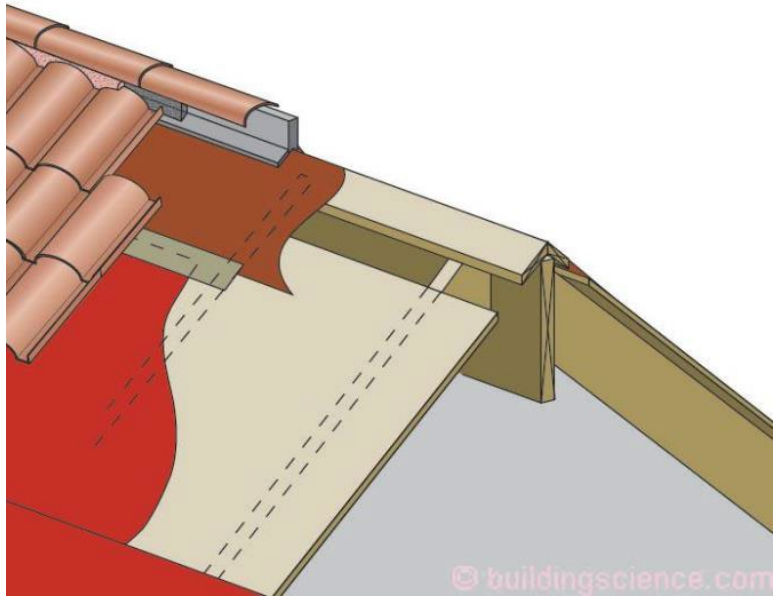


Recommendation by Building Science Corp.



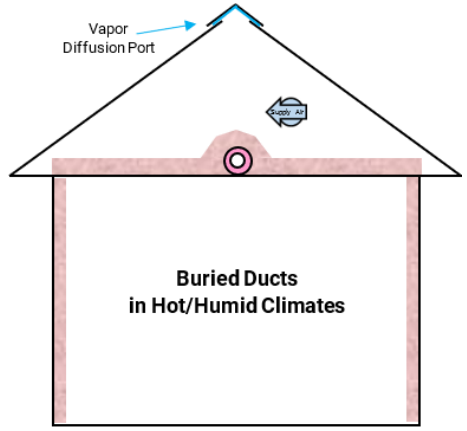
Adaptation to address counter-flashing





- Any shelf ridge vent works.
- The only change is covering the vent area cut through the sheathing with a water tight but vapor open covering. A high perm “housewrap” works – over 20 perms. Must also be considered an air barrier and water-resistant barrier.

Testing Outcomes – Stage 3 Test



Third Option

- *(change) Unvented Attic*
- *(add) Vapor Diffusion Vent*
- *(add) Supply Air, 50cfm/1000sf of attic floor*
- R-38 Attic
- R-8 Buried under R-30

Smaller test attics required some engineering to get 50cfm/1000sf

- **Timing – Late Summer 2022 to Summer 2023**
- **Experimental Procedure –**
  - R-8 ducts buried under R-30 loosefill insulation (meeting R-38 thermal requirement) in an **unvented attic**
  - Install **vapor diffusion vent at ridge vent** to allow attic and occupant created moisture to escape (meeting water, air & vapor barrier requirements… IRC R806.5.2)
  - Added **supply air** to aid in drying the attic
    - *50cfm of supply air per 1,000 sf of attic floor*
    - very small energy penalty
- **Outcomes –**
  - Adding of the supply air adequately addressed the potential of duct condensation build while system was in operation even when stressing the system to 65F setpoints and under the white metal “cool roof”.
  - Once supply air was added, top of duct RH stayed between 40% and 80% during runtime which is considered safe.
  - Added air leakage to metal boots to determine potential of condensation. Dry air leak provided adequate drying and saw/measured no results of condensation at all on metal boots/registers.
  - Roof deck moisture @ or below 12% moisture content even when system was not calling for air. <16% moisture content is considered safe.
- **Next Steps –**
  - This solution was determined to be a safe solution for climate zones 0A, 1A, 2A & 3A

Proposed Added Language

2.2.2. Air shall be supplied to the unvented attic at a flow rate greater than or equal to 50 CFM (23.6 L/s) per 1,000 square feet (93 m2) of ceiling. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, conditioned air shall be supplied by a supply fan into the attic when the conditioning system is operating.

"Belt and Suspenders"

Testing Outcomes – Stage 3 Test (Data)

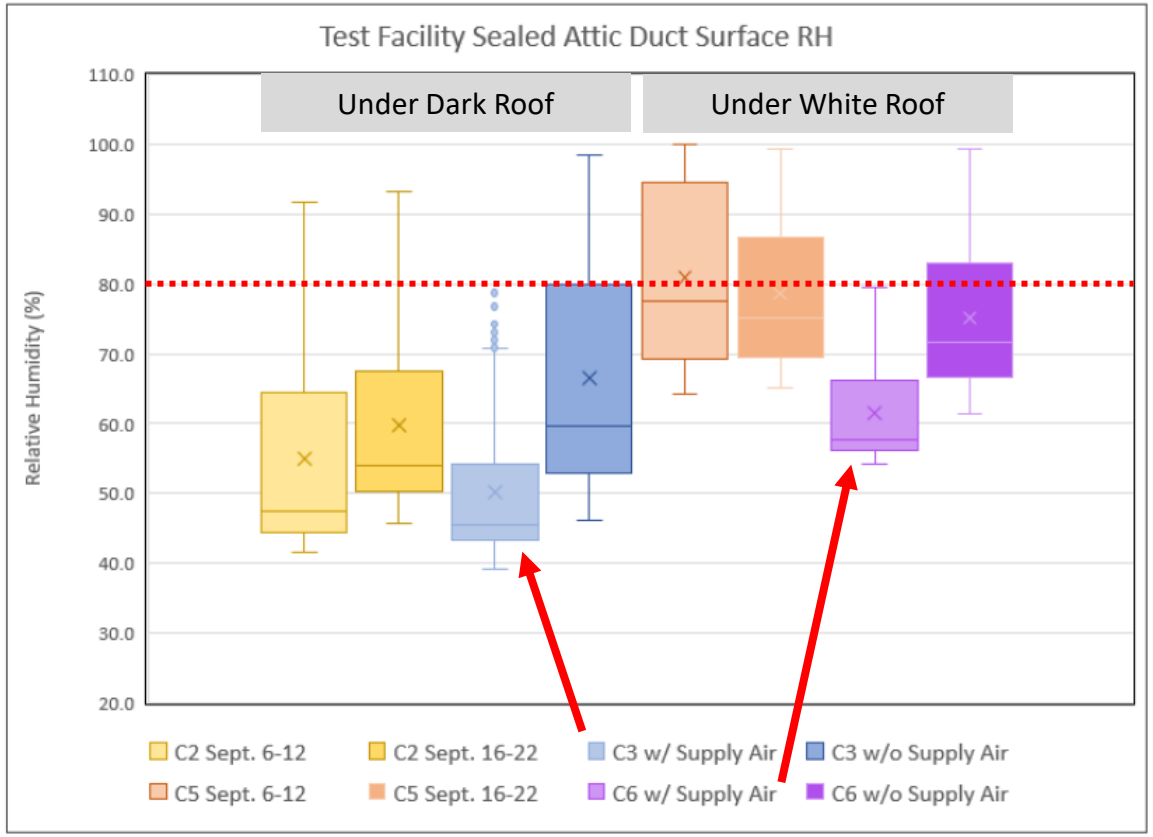


Figure 5. Test facility hourly duct outer jacket RH box and whisker plots for Cells 2, 3. 5, and 6, comparing the seven day period with supply air provided to Cell 3 and 6 (September 6 – 12) and seven day period after the supply air to these cells was sealed off (September 16 – 22).

Table 2. Test facility average outdoor air, outdoor dew point, and indoor air temperatures, and Cell 1-6 top of duct RH levels for seven day period during Cell 3 and 6 supply air to attic test and seven day period after test with supply air sealed.

Supply Air Provided to Cell 3 & 6 Attics?	Outdoor Temp (F)	Outdoor Tdp (F)	Indoor Temp (F)	C1 Dark Roof w/ Vent. Attic Duct Top RH (%)	C2 Dark Roof w/ Sealed Attic Duct Top RH (%)	C3 Dark Roof w/ Sealed Attic Duct Top RH (%)	C4 White Roof w/ Vent. Attic Duct Top RH (%)	C5 White Roof w/ Sealed Attic Duct Top RH (%)	C6 White Roof w/ Sealed Attic Duct Top RH (%)
Yes (Sept. 6 - 12)	79.3	73.8	68.7	59.5	55.0	50.2	71.8	80.9	61.6
No (Sept. 16 - 22)	77.9	73.1	68.7	61.6	59.8	66.6	77.1	78.6	75.1
Difference	1.4	0.7	0.0	-2.2	-4.8	-16.4	-5.3	2.3	-13.6

Table 2 demonstrates that providing attic supply air significantly decreased duct surface condensation potential.

- The top duct surface average RH for dark shingle roof Cell 3 with attic supply was a dry 50% RH, a reduction of 16% RH.
- The top duct surface average RH for attic supply under white metal roof Cell 6 was only 62% RH, a reduction of 14% RH.
- Comparing Cell 3 to Cell 2 during the attic supply period, Cell 3 with supply was 5% RH less than Cell 2 (this is due to much hotter Cell 2 temperature that helped depress the RH).
- Interestingly the difference between Cell 6 and Cell 5 during the attic supply period, shows a remarkable 19% RH drop for Cell 6 with attic supply. This is believed to be due to much less heating differential between attic cells under the reflective white metal roof in addition to the introduction of the dryer supply air to the attic.

Impact – Energy & Cost

IMPACT → DUCTWORK AS A % OF TOTAL BUILDING ENERGY USE

Example: Climate Zone 2A - Boca Raton, FL

Existing Housing (Typical)		Duct Air Leakage	Ductwork as % of Total Building Energy Consumption		Heating & Cooling Impact (Based on Run Time) Annual			Homeowner $$s lost due to Inefficiency (Annual Cooling Days Only / Electric)		
			Heating %	Cooling %	Heating Loss BTU	Cooling Loss BTU	Total Loss BTU	Lowest Cost @ 0.10/kWh	Average Cost @ 0.15/kWh	Highest Cost @ 0.30/kWh
Suspended Ducts (Attic)	R-4.2	32-33%	**33.8**	**35.6**	959,892	44,906,616	**45,866,508**	$ 1,316	**$ 1,974**	$ 3,948
	R-4.2	26-27%	27.8	30	724,388	34,805,160	**35,529,548**	$ 1,020	**$ 1,530**	$ 3,060

New Construction (Typical)

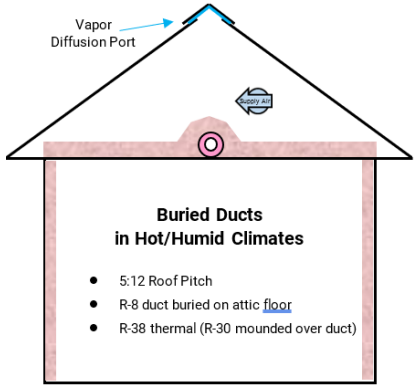
Suspended Ducts (Attic)	R-8	10%	**11.9**	**14.7**	252,888	14,018,544	**14,271,432**	*baseline*	$ 411	**$ 616**	$ 1,233
	R-8	4%	10.6	13.6	221,728	12,745,008	**12,966,736**	-9%	$ 374	**$ 560**	$ 1,121
							includes 50cfm of supply air				
Completely Buried Ducts (Attic)	**Effective R-25**	10%	6.3	7.1	126,936	6,251,904	**6,378,840**	-55%	$ 183	**$ 275**	$ 550
		4%	4.8	5.7	95,284	4,934,952	**5,030,236**	-65%	$ 145	**$ 217**	$ 434
		1.5% (E*)	4.1	5	80,688	4,312,656	**4,393,344**	-69%	$ 126	**$ 190**	$ 379
							includes 50cfm of supply air				
Deeply Buried Ducts (Attic)	**Effective R-38 (R8 + R30)**	10%	5.7	6.1	131,036	6,127,750	**6,258,786**	-56%	$ 180	**$ 269**	$ 539
		4%	**3.7**	**4.2**	90,692	4,342,500	**4,433,192**	-69%	$ 127	**$ 191**	$ 382
		1.5% (E*)	3.1	3.6	75,768	3,691,125	**3,766,893**	-74%	$ 108	**$ 162**	$ 325
		attic @ 3.0ACH									
R-22 @ Roof Deck (Suspended Ducts)	R-4.2 or 6	4%	**9.9**	**8.3**	198,604	7,202,232	**7,400,836**	-48%	$ 211	**$ 317**	$ 633
	R-4.2 or 6	1.5%	8.6	6.9	169,576	5,870,808	**6,040,384**	-58%	$ 172	**$ 258**	$ 516

R-8 Ducts, Deeply Buried in Attic (Meeting thermal attic code → 30/38/49)

R-22 SPF @ Roof Deck (vs) R-38 Deeply Buried (mounded)

- ❑ **Lower potential for thermal exchange in the duct. June/July/August 2024 results (Cocoa, FL test lab)**

  - 70.1°F average at top of duct
    - ✓ 2° higher than cond. space
    - ✓ 120-140° if suspended



  - 73.1°F average at top of duct

Remaining Actions:

1) **Validate that completely & deeply buried ducts = DICS**
   - ✓ "Effective R-value" of Buried Ducts testing → *via Oak Ridge National Lab (TBD 2025)*

2) **Update performance softwares → via NREL/DOE trials**

Builder Costs:

CZs 1A -3A: Costs to Move from a Suspended Duct in Vented Attic to R-8 Buried Ducts in Unvented Attic				
		Worse Case	Typical	Better Case
Who?	Description	Tonnage Reduction		
		0.5 tons	1.0 tons	1.5 tons
HVAC	**HVAC System Tonnage Reduction**	$ (600)	$ (1,200)	$ (1,800)
HVAC	R-6 to R-8 Ducts	$ ~~100~~	$ ~~100~~	$ ~~100~~
HVAC	Duct Air Sealing (Mastic)	$ ~~250~~	$ ~~250~~	$ ~~250~~
Insulation	25% Material Overage (5-6 bags of loosefill on 1,100 sf attic)	$ 250	$ 250	$ 250
Insulation	Additional Labor for Insulation (duct rulers & install time)	$ 75	$ 75	$ 75
Insulation	Air Sealing (Register to Gypsum)	$ ~~75~~	$ ~~75~~	$ ~~75~~
	Actions to Unvent Attic (CZs 1A - 3A)			
Roofer	Diffusion Port Fabric @ Roof Ridge (Material + Labor)	$ 150	$ 150	$ 150
Framer/Cornice	Sealing of Attic - Unveted Soffit	$ 400	$ 400	$ 400
Framer/Cornice	Sealing of Attic - Truss Blocking	$ -	$ -	$ -
Total Impact to Builder (Additional Cost)		**$ 700**	**$ 100**	**$ (500)**
		+275	(-$325)	(-$925)

Estimated cost in GA: $875

SUPPORTERS OF THIS APPROACH

- Owens Corning*
- GreenFiber*
- NAIMA
- NAHB
- Leading Builders of America
- GEFA
- EarthCraft
- Greater Atlanta HBA
- Southface
- Building Science Inc
- FSEC

* Manufacturing in GA

Proposed Amendments

INTENT

- Provide builders and HVAC designers a new option in the GA Energy Code for bringing ductwork into conditioned space
- Clarify and simplify existing model code language to meet specific GA climate zone requirements
- Ensure proper installation of systems

PROOF OF PERFORMANCE

- Proposed language is already used in the relevant portions of the 2018 and 2021 IECC
- Extensive research by US DOE has produced guidance addressing condensation concerns
- Industry has current partnerships with Florida Solar Energy Center (FSEC) to verify and further maximize the efficiency of this strategy in neighboring states

TWO PROPOSED OPTIONS AND ONE DEFINITION

1. Ducts that are in Conditioned Space (R-8 ducts covered with at least R-30 insulation)
2. Ducts that are Buried in insulation (R-8 covered with at least R-19 insulation)

3. The third amendment proposes how to define the R-value of buried ducts (duct R-value + insulation above it)

1: R403.3.7 DUCT SYSTEMS LOCATED IN CONDITIONED SPACE

R403.3.7

Summary:

Defines ducts that are in Conditioned Space (R-8 ducts covered with at least R-30 insulation)

R403.3.7 Duct Systems Located in Conditioned Space (Optional)

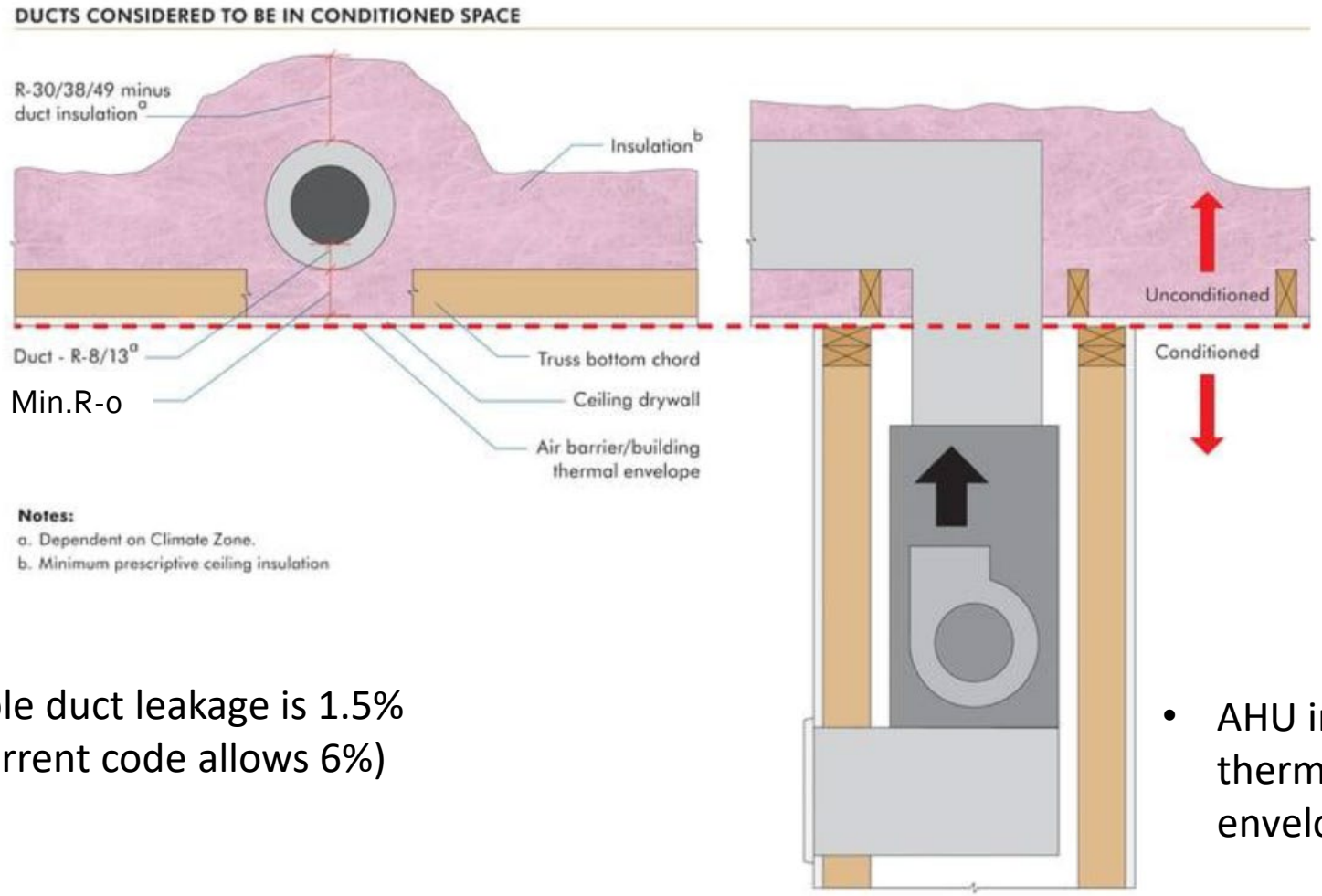
For *duct systems* to be considered inside a *conditioned space,* the *space conditioning equipment* shall be located completely on the conditioned side of the *building thermal envelope*. The *ductwork* shall comply with Section R403.3 and the following as applicable:

1. The *ductwork* shall be located completely on the conditioned side of the *building thermal envelope*.
2. *Ductwork* in ventilated attic spaces or unvented attics with vapor diffusion ports shall be buried within ceiling insulation in accordance with R403.3 and shall comply with the following:
   - 2.1 The air handler is located completely within the continuous air barrier and within the building thermal envelope.
   - 2.2 The *ductwork* leakage, as measured either by a rough-in test of the supply and return ductwork or a post-construction *duct system* leakage test to outside the *building thermal envelope* in accordance with Section R403.3.3, shall not exceed 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m2) of *conditioned floor area* served by the *duct system* and shall comply with total leakage requirements of R403.3.4.
   - 2.3 The ceiling insulation R-value installed against and above the insulated *ductwork* shall be greater than or equal to the proposed ceiling insulation R-value, less the R-value of the insulation on the *ductwork*.

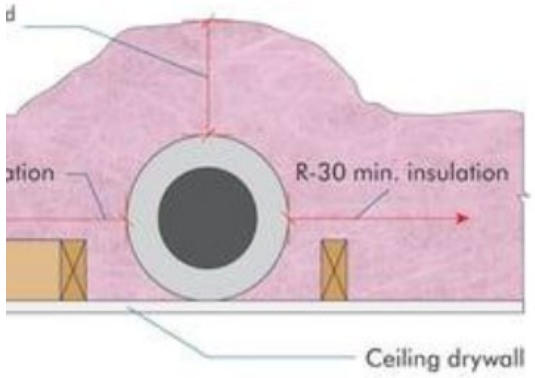
AMENDMENT ONE: R403.3.7 DUCT SYSTEMS LOCATED IN CONDITIONED SPACE

R403.3.7

R-30 insulation + R-8 Ducts = GA Code Requirement of R-38



- Allowable duct leakage is 1.5% (GA's current code allows 6%)



- AHU inside thermal envelope

R-25 insulation + R-13 Ducts = GA Code Requirement of R-38

Image Source: Insulation Institute, Deeply Buried Ducts, https://information.insulationinstitute.org/blog/new-options-for-hvac-duct-design

2: R403.3.8 DUCTWORK BURIED WITHIN CEILING INSULATION

R403.3.8

Summary:

Ducts that are buried in insulation (R-8 covered with at least R-19 insulation)

R403.3.8 Ductwork Buried Within Ceiling Insulation (Optional)

Where supply and return ductwork is partially or completely buried in ceiling insulation, such ductwork shall comply with the following:

1. The supply and return ductwork shall be insulated with not less than R-8 insulation.
2. At all points along the ductwork, the ceiling insulation R-value against and above the top of the insulated ductwork shall be not less than R-19.
3. In Climate Zones 2A and 3A the supply ductwork shall be completely buried within ceiling insulation, insulated to an R-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.

    Exception 1: Sections of the supply ductwork that are less than 3 feet (914 mm) from the supply outlet.

    Exception 2: In Climate Zones 2A and 3A where installed in an unvented attic with vapor diffusion ports, the supply ductwork shall be completely buried within the insulation in the ceiling assembly at the floor of the attic, insulated to an R-value of not less than R-8 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.

AMENDMENT TWO: R404.3.8 DUCTWORK BURIED WITHIN CEILING INSULATION – UNVENTED ATTIC WITH VAPOR DIFFUSION PORTS

R403.3.8

- At all points along the ductwork, the ceiling insulation R-value against and above the top of the insulated ductwork shall be not less than R-19
- Allowable duct leakage is 6% (GA's current code)

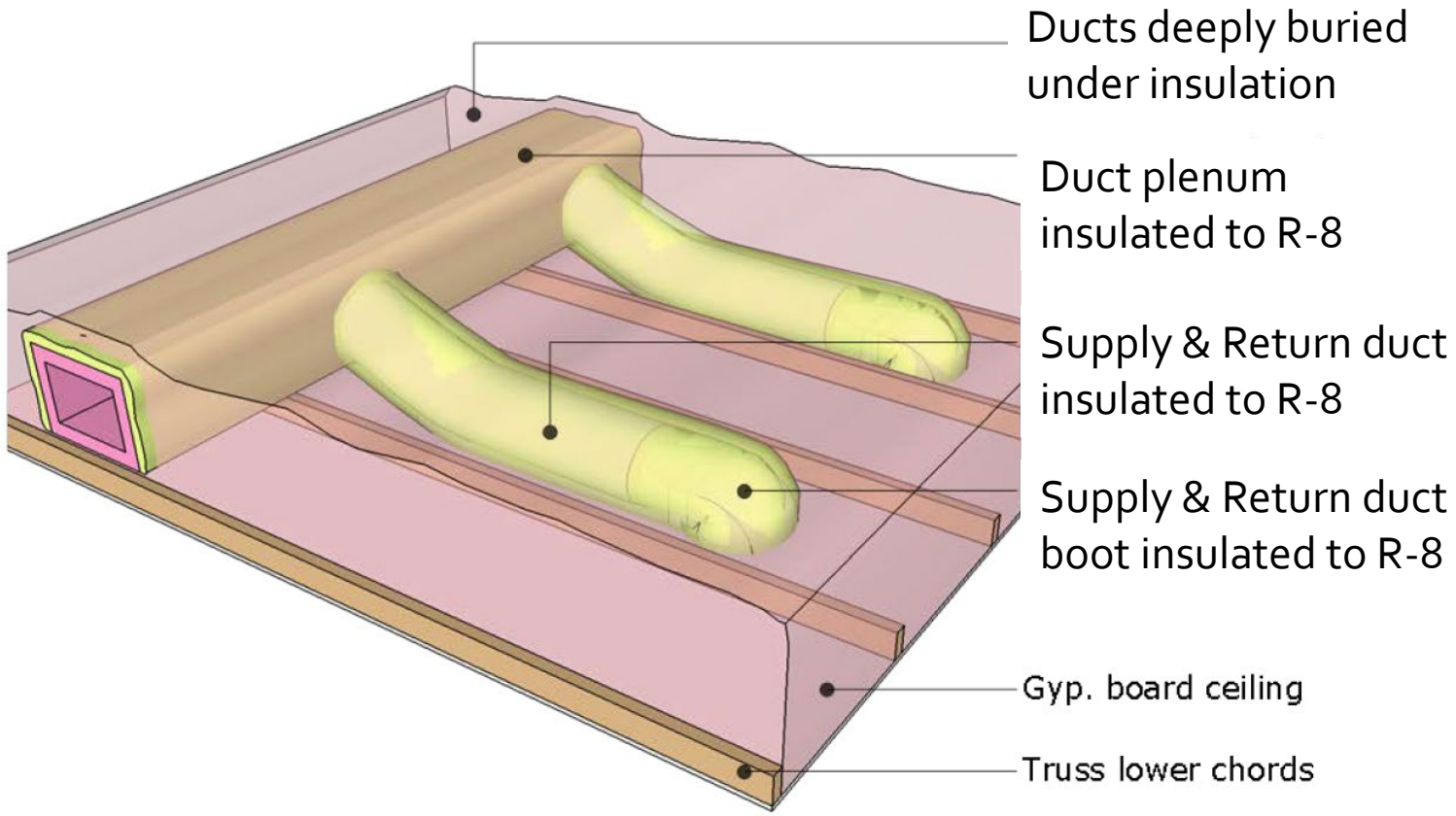


Figure 4. Detail of buried and encapsulated duct

Image Source: Shapiro et al, *Reducing Thermal Losses and Gains with Buried and Encapsulated Ducts in Hot-Humid Climates*

3. R403.3.9 R-VALUE OF DEEPLY BURIED DUCTS

R403.3.9

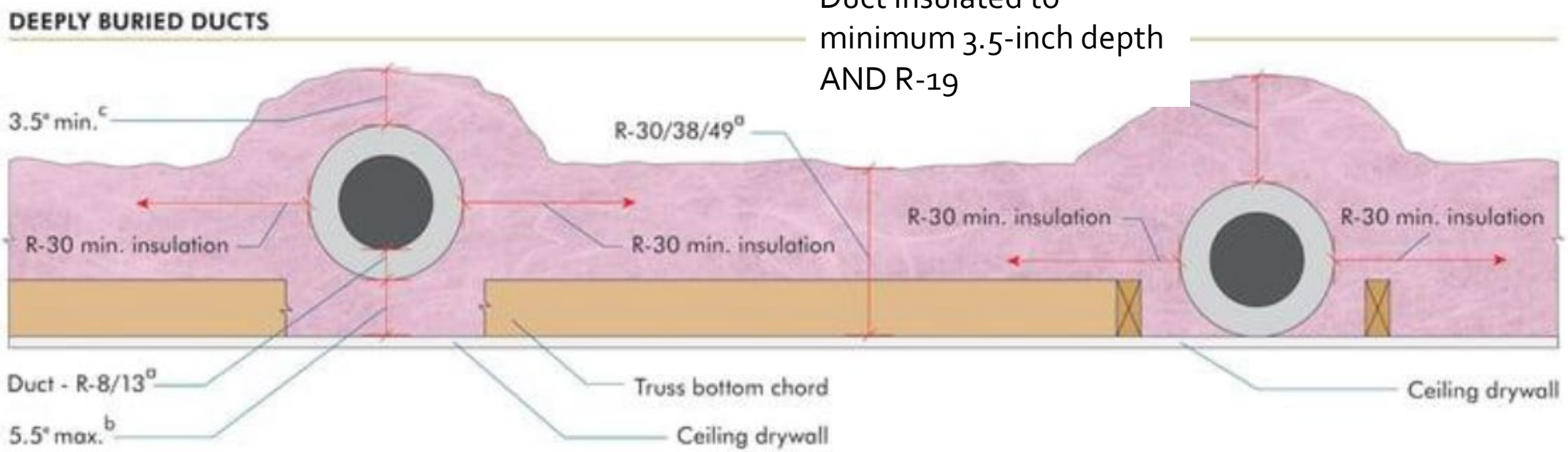
Summary:

The third amendment defines the R-value of buried ducts (duct R-value + insulation above it)

R403.3.9 *R*-value of Deeply Buried Ducts (Optional)

Where complying using Section R405, the sections of ductwork that are installed in accordance with Section R403.3 surrounded with blown-in attic insulation having an *R*-value of R-30 or greater, and located such that the top of the ductwork is not less than 3.5 inches (89 mm) below the top of the insulation and covered by a minimum R-19, the ductwork insulation R-value of the ductwork shall be considered the combined R-value of the ductwork insulation plus the ceiling insulation above the ductwork.

AMENDMENT THREE: R403.3.9 DEFINES R-VALUE OF DEEPLY BURIED DUCTS



Duct insulated to minimum 3.5-inch depth AND R-19

R403.3.9

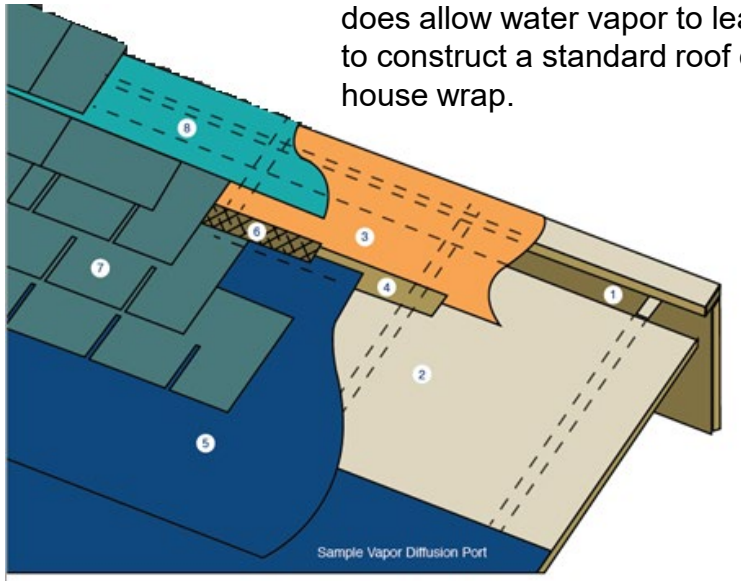
Total duct R-value is R-value of duct + R-value of insulation above it

Image Source: Insulation Institute, Deeply Buried Ducts, https://information.insulationinstitute.org/blog/new-options-for-hvac-duct-design

UNVENTED ATTIC WITH VAPOR DIFFUSION PORTS – ALLOW R-8 INSTEAD OF R-13 FOR BURIED DUCTS

Getting Vapor Diffusion Ports Right

A vapor diffusion port prevents air from moving in or out of the attic – but it does allow water vapor to leave the space. One way of building the port is to construct a standard roof or ridge vent but seal the vent with a typical house wrap.

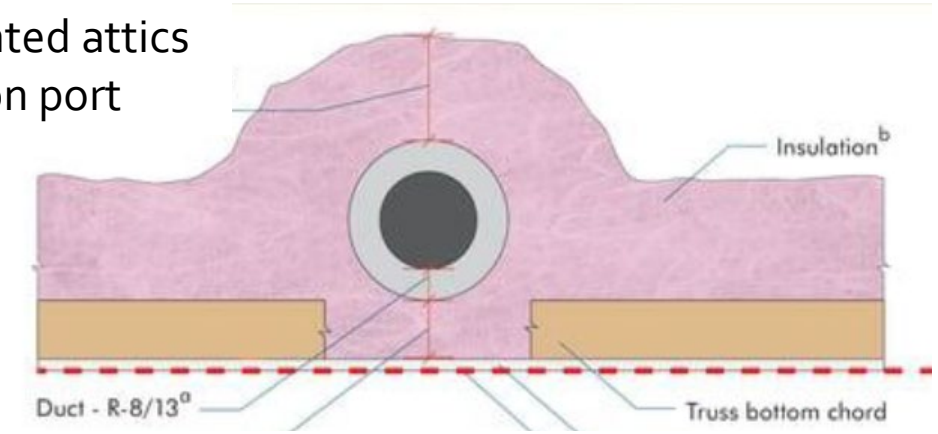


01. Vent holes or strip cut in roof sheathing sized per the IRC code requirement or 1/600th of the ceiling area.
02. Roof sheathing.
03. Membrane that is vapor permeable but prevents air from entering – housewrap is typically used in this application.
04. Durable adhesive tape (compatible with both surfaces) holds the vapor permeable membrane (3) in place and air seals between the roof sheathing (2) and the membrane (3).
05. Roofing underlayment – typically 15 or 30 pound asphalt felt.
06. Durable adhesive tape that is compatible with both surfaces to hold the roofing underlayment in place.
07. Asphalt roofing shingles - or other low perm material in contact with the roof.
08. Typical roof ridge vent to protect the membrane (3) and prevent rain, snow, and debris from entering.

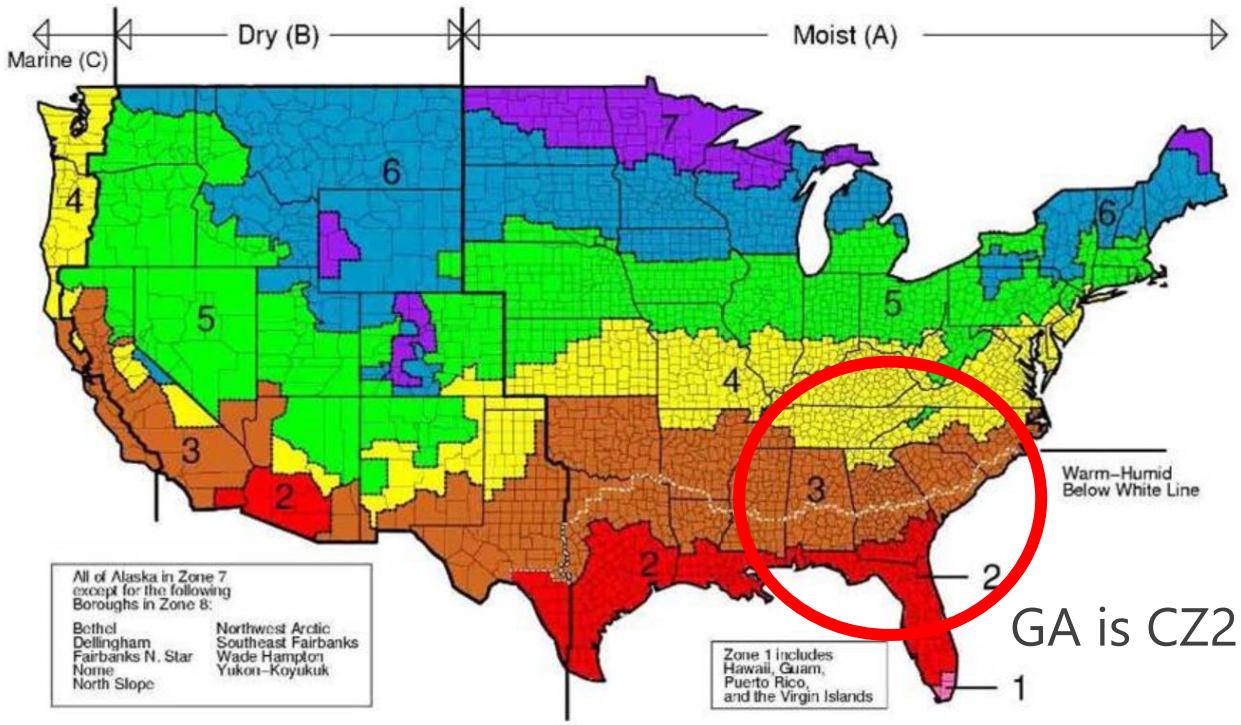
Image Source: Insulation Institute, *Building Unvented Attic Assemblies – No89*

Georgia State Minimum Standard One and Two Family Dwelling Code, Chapter 2 Definitions: **[RB] VAPOR DIFFUSION PORT.** *A passageway for conveying water vapor from an unvented attic to the outside atmosphere.*

- Ducts insulated to R-13 in vented attics
- Ducts R-8 in unvented attics with vapor diffusion port

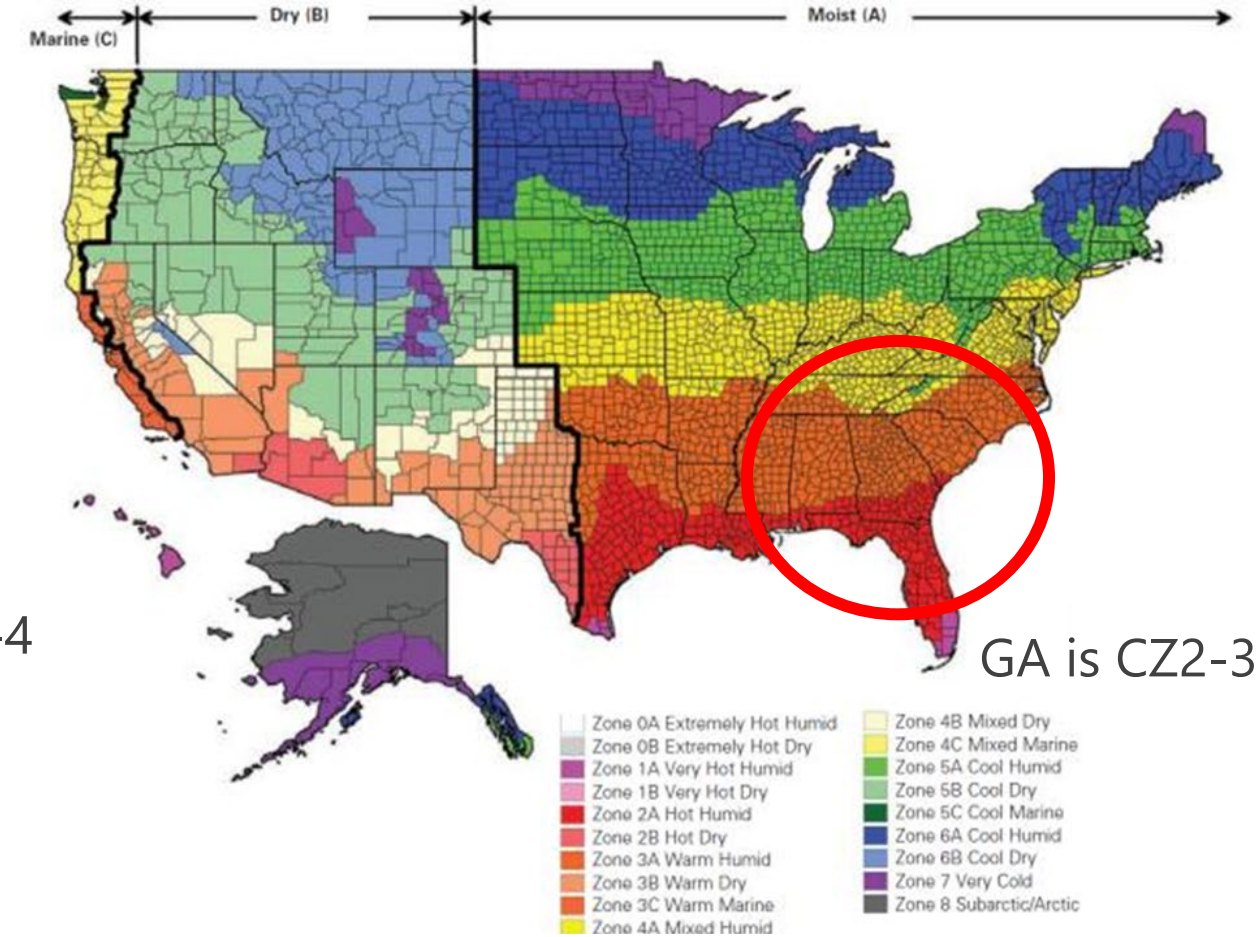


CLIMATE ZONES REDRAWN IN 2021



GA is CZ2-4

IECC 2003-18 Climate Zones



GA is CZ2-3

IECC 2021 Climate Zones