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Buried Ducts: Advantages, Challenges, and New Options in the 2018 IECC

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U.S. Department of Energy Building Energy Codes Program
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Course Description

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The concept of burying ducts is not new, but the prescriptive requirements in the 2018 International Energy Conservation Code (IECC) are. This training session provides a brief look at the research behind buried ducts, the prescriptive code language in the 2018 IECC, practical information on how builders can use the practice today (even if their jurisdiction doesn't yet have the 2018 IECC), and an overview of the energy and cost benefits of the approach compared to traditional or unvented attics.

Learning Objectives

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At the end of this course, participants should be able to understand:

1. An overview of past research done on bringing ductworks into conditioned space.
2. A detailed summary of the code changes. There are variants of buried duct approaches with different code, and energy modeling, implications.
3. A description of how builders can use this practice today, even if their area is not yet on the 2018 IECC.
4. An overview of the energy and cost benefits of this approach compared to traditional or unvented attic design.
5. A synopsis of relevant field research proving out this practice by showing how it can be done effectively, and safely, in all climates, even hot/humid ones.

National Association of Home Builders

Buried Ducts: Advantages, Challenges, and New Options in the 2018 IECC

November 9, 2017

Craig Drumheller
NAHB
Director- Construction Codes and Standards

What are Buried Ducts?

Buried Ducts are…
Ducts Buried within Attic Insulation of Vented Attics

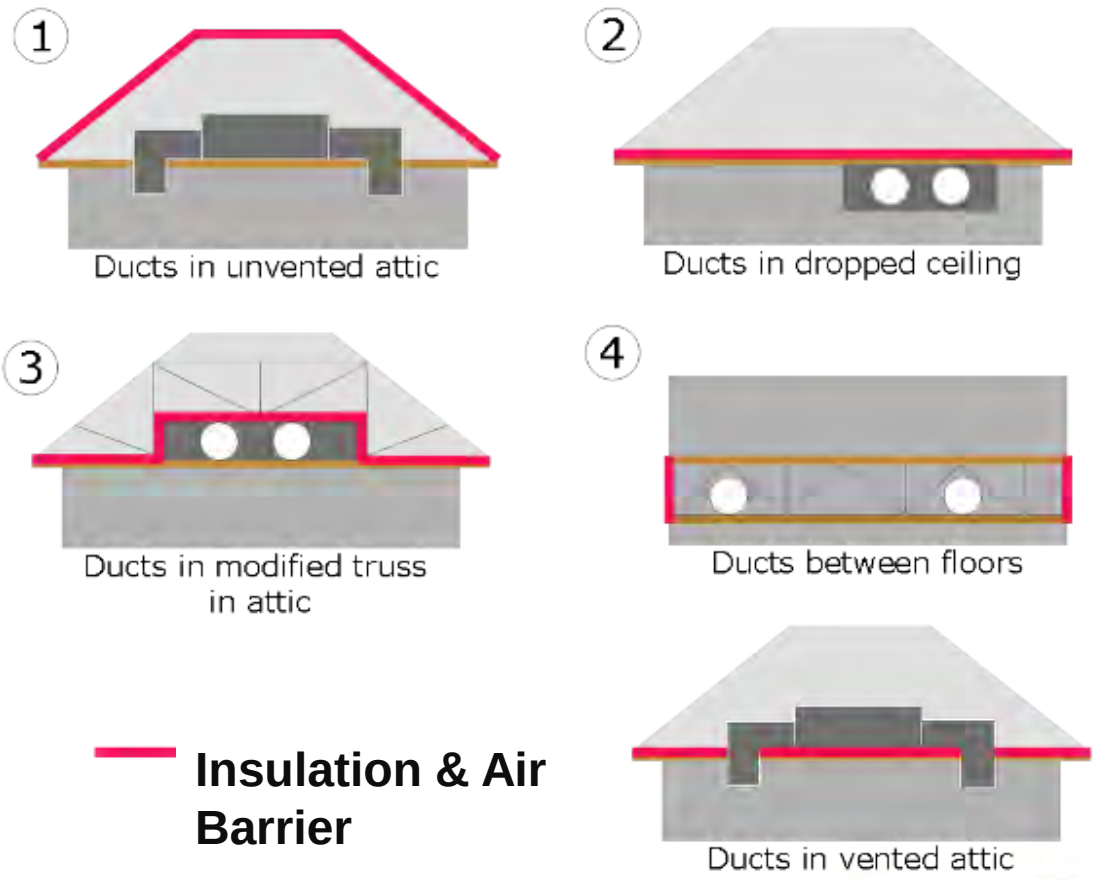
Image courtesy of Home Innovation Research Labs[1]

Advantages of Buried Ducts

- Saves energy vs. ducts exposed in attics
- Typically a lower cost solution to bringing ducts fully into conditioned space
- Can easily be implemented
- Does not require high-tech solutions

Buried Ducts vs. Attics

- Ductwork in vented attics traditionally have had thermal losses from 10-45%
- Interior ducts may be impractical, expensive, or increase envelope loads based on house design



Images courtesy of Steven Winter Associates, Inc.

Ducts in Unvented Attic

HVAC design flexibility

Minimal design integration

Considerably more expensive

May increase enclosure loads

Images courtesy of Steven Winter Associates, Inc.

Ducts in Dropped Soffit

- Requires high-level of architectural integration
- More complicated install ensuring proper air barrier and coordinating trades

Image courtesy of Steven Winter Associates, Inc.

Image courtesy of Building Science Corp.

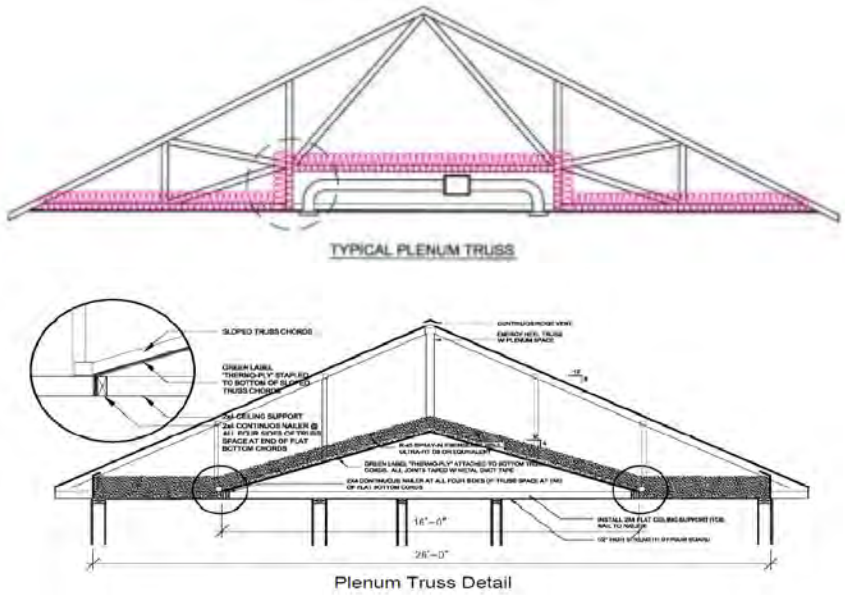
Floor Truss Integrated Ducts

- Must have deep open trusses
- Only in 2-story or with conditioned basement

- Conducive to floor registers which don't work as well for cooling
- Cost-effective

Images courtesy of Steven Winter Associates, Inc.

Ducts in Modified Truss



Plenum Truss Detail

- Works well in narrow plans
- Moderate cost-increase

- Sealing the air-barrier is critical
- Design integration required
- Coordination of trades

Images courtesy of Steven Winter Associates, Inc.

Concerns

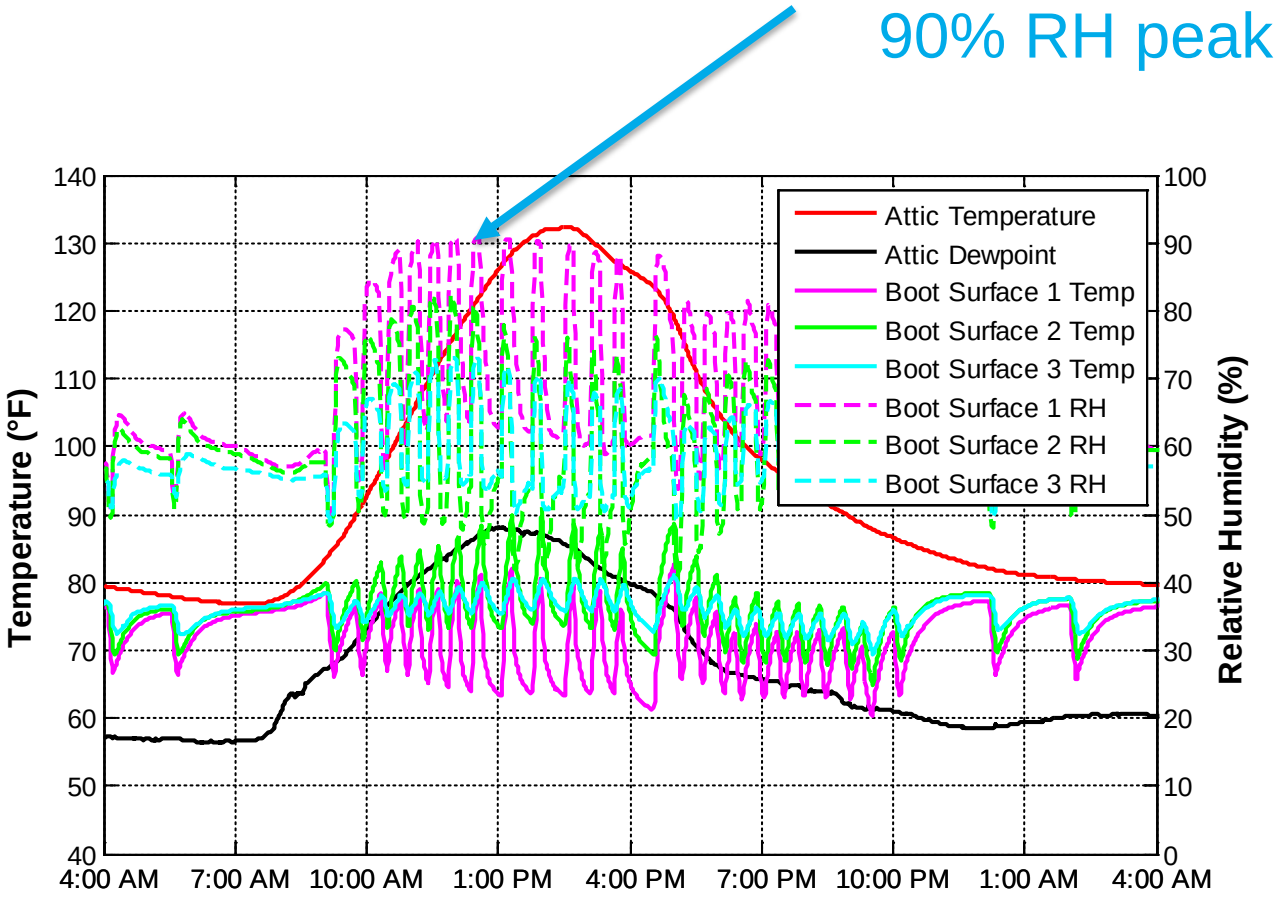
- Condensation on ducts when air conditioning in humid climates
- Displaced attic insulation resulting in reduced efficiency
- New concern, air conditioned delivery temperature may be up to 7 degrees cooler than previously increasing condensation potential on register supply boot.

Buried Duct Research

Over 15 years of research performed by a number of teams involved in DOE's Building America program

- Steven Winter Associates
- Home Innovation Research Labs
- Florida Solar Energy Center

Condensation Potential



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Condensation Potential Encapsulated Ducts

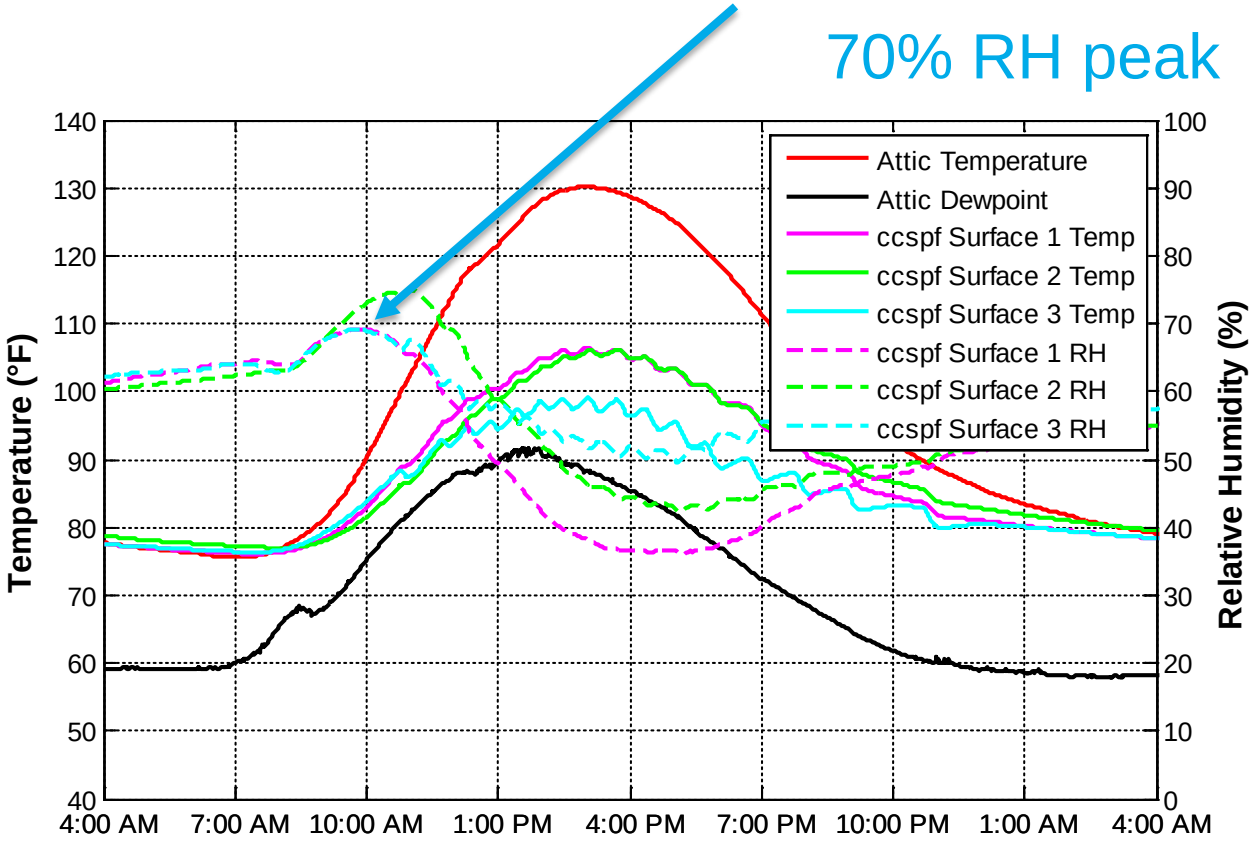


Image courtesy of Steven Winter Associates, Inc.

Reduced Delivery Temperature

Home Innovation research recorded a 7 F reduction in delivery temperature with buried ducts.

Clearly saves energy over exposed ducts

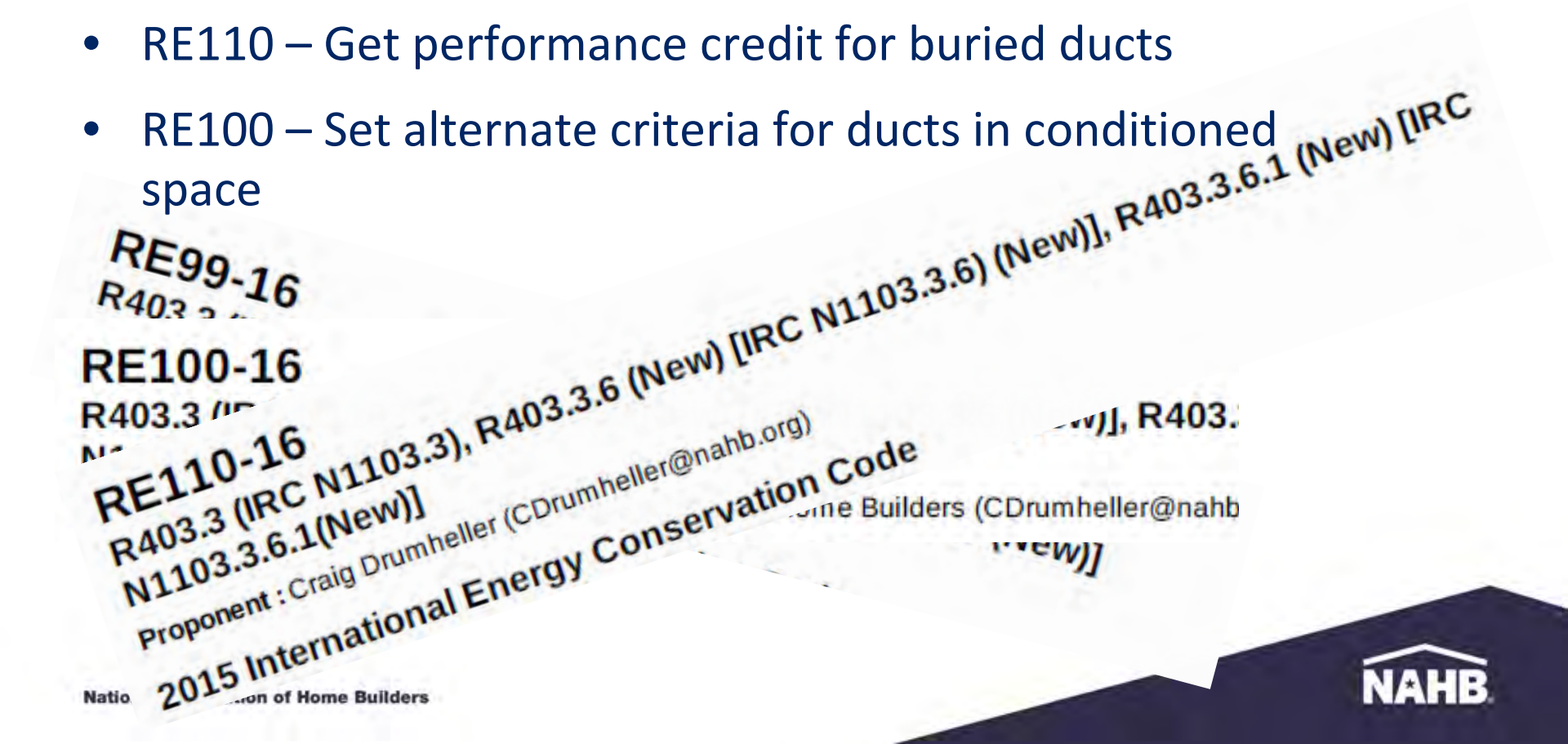
Also increases the opportunity for condensation, most notably at the boot near the supply register.

Why the Need for the Code Change?

- Some Jurisdictions do not allow builders to bury ducts
  -Concerns about condensation
  -Concerns about reduced efficiency
- There was no guidance in the code on how to address condensation
- Builders would receive no credit for the energy efficiency provided by buried ducts
- There was a desire to have an alternate equivalence to a duct being in conditioned space.

Buried Ducts In Attic Insulation
Changes to the 2018 IECC

- Three Code Change Proposals- Three purposes
- RE99 – Explicitly allow buried ducts
- RE110 – Get performance credit for buried ducts
- RE100 – Set alternate criteria for ducts in conditioned space



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Ducts buried under insulation in a vented attic is a viable builder practice (option)

- Ducts placed on the ceiling drywall or over the bottom truss chords.
- Attic insulation covers (buries) the ducts.
- Reduces thermal losses from ducts located in vented attics.
- Must consider condensation in humid climates

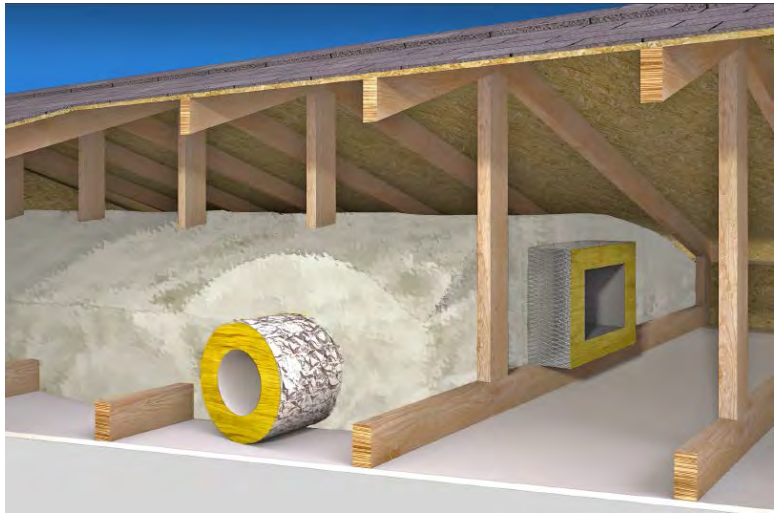


Image courtesy of Home Innovation Research Labs[1]

[1]Home Innovation Research Labs. TechSpecs A Builder's Blueprint for Construction Technologies (January 6, 2017). HVAC Ducts Buried Within Ceiling Insulation in a Vented Attic (Buried Ducts).

New Options for Buried Ducts in the 2018 IECC

Prior code editions did not disallow the use of buried ducts, but did not specify conditions for performance and compliance

2018 code now recognizes the practice of buried ducts, specifying:

- Insulated duct R-value by climate zone
  - Addresses moisture concerns
- Minimum attic insulation around ducts
  - Addresses energy performance
- Performance path energy compliance
  - Specifies parameters to be entered in software

Code Requirements: Ducts buried within ceiling insulation

Ducts may be partially or fully buried under attic insulation.

1. Duct Insulation:

- Minimum of R-8 for supply and return ducts; however…
- CZ's 1A, 2A, 3A require R-13 for buried supply ducts.

2. Ceiling Insulation:

- Above and below duct should total R-19, not including duct R-value

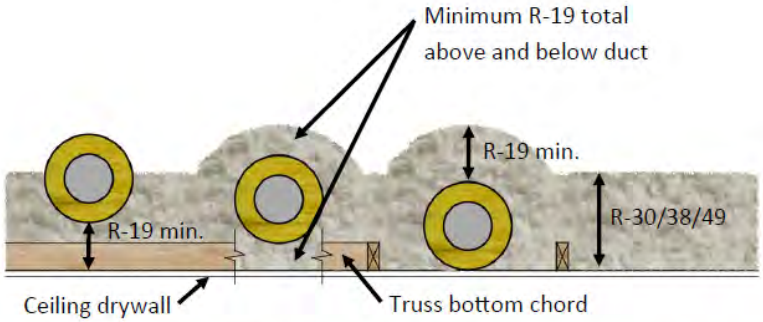
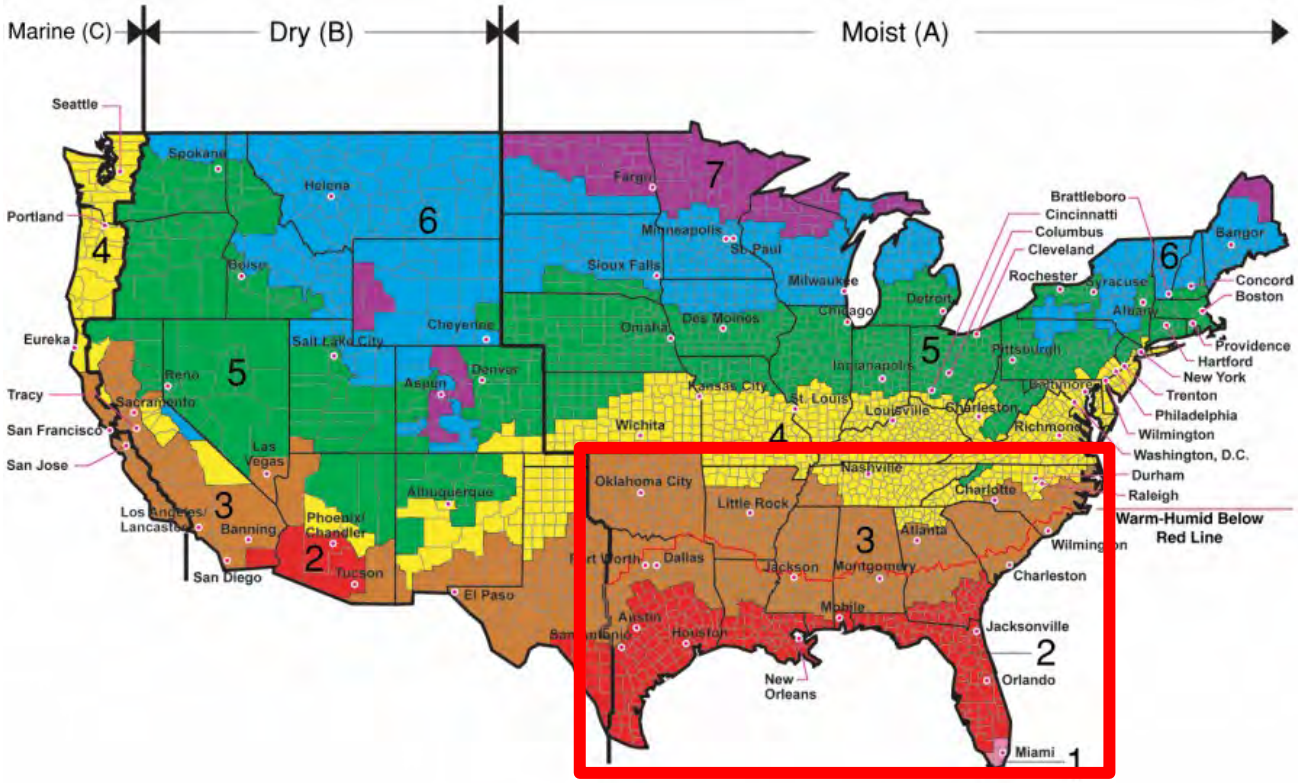


Figure 2. *Example partially buried duct (left), buried duct across the truss bottom truss chord (middle), and buried duct on the ceiling (right).*

[1]Home Innovation Research Labs. TechSpecs A Builder's Blueprint for Construction Technologies (January 6, 2017). HVAC Ducts Buried Within Ceiling Insulation in a Vented Attic (Buried Ducts).

Climate Zone and Moisture Map



Climate Zones 1A, 2A and 3A

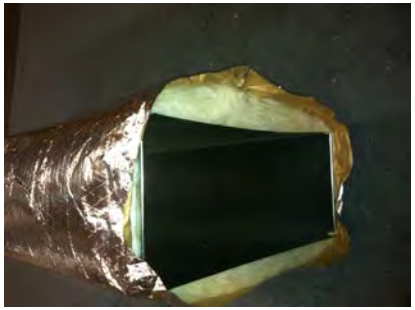
- All buried ducts must be R-13 or greater

All other Climate Zones

- All buried ducts must be R-8 or greater

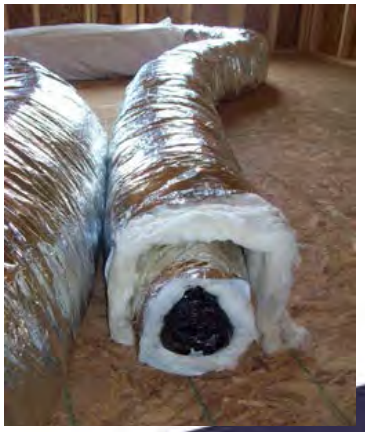
How to achieve an R-13 Duct

- Metal duct wrapped in R-13 insulation



- R-8 Duct Encapsulated with 1” ccSF

- Concentric R-8 flex ducts



RE99- Ducts Buried Within Ceiling Insulation

R403.3.6 Ducts buried within ceiling insulation. Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.

2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the *R*-value of the duct insulation.

3. In *Climate Zones* 1A, 2A and 3A, the supply ducts 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: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

Code Requirements: Deeply buried duct effective R-value

Ducts, or portions of ducts installed as "deeply buried" may claim an effective R-value of 25.

1. General requirements/duct insulation:

- Follow general requirements and duct insulation described previously

2. Duct Location:

- On or within 5.5" of ceiling drywall

3. Ceiling Insulation:

- R-30 surrounding duct
- Top of the duct is 3.5" below insulation

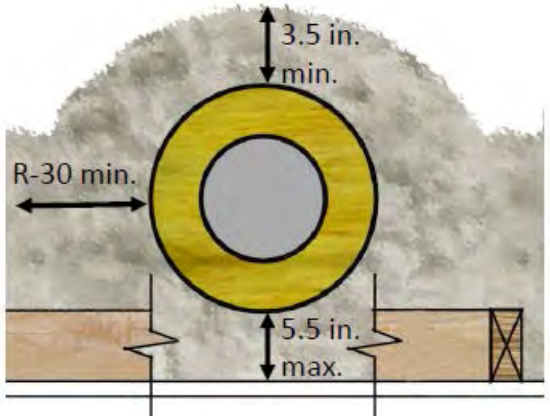


Image courtesy of Home Innovation Research Labs[1]

[1]Home Innovation Research Labs. TechSpecs A Builder's Blueprint for Construction Technologies (January 6, 2017). HVAC Ducts Buried Within Ceiling Insulation in a Vented Attic (Buried Ducts).

RE110- Deeply Buried Ducts

R403.3.6.1 Effective *R*-value of deeply buried ducts.

Where using a simulated energy performance analysis, sections of ducts that are: installed in accordance with Section R403.3.6; located directly on, or within 5.5 inches (140 mm) of the ceiling; surrounded with blown-in attic insulation having an *R*-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation *R*-value of R-25.

Code Requirements:
Ducts located in conditioned space

Buried ducts may be considered ducts in the conditioned space when installed as:

1. General requirements/duct insulation:

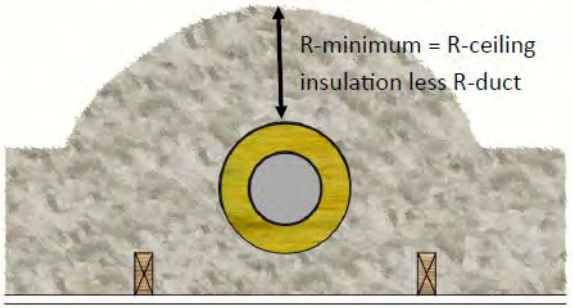
- Follow general requirements and duct insulation described previously

2. Air Handler Location:

- Within the conditioned space

3. Duct Leakage:

- Post-construction total system leakage to outside of 1.5cfm/100sf CFA



4. Ceiling Insulation:

- Insulation R-value against and above the duct ≥ proposed ceiling R-value –(minus) duct R-value

RE100- Ducts in Conditioned Space

R403.3.7 Ducts located in conditioned space. For ducts to be considered as inside a conditioned space, such ducts shall comply with either of the following:

1. The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.

2. The ducts shall be buried within ceiling insulation in accordance with Section R403.3.6 and all of the following conditions shall exist:

2.1. The air handler is located completely within the *continuous air barrier* and within the building thermal envelope.

2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section R403.3.4, is less than or equal to 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.

2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

Implementing buried ducts with previous code editions

The 2018 IECC has just been published, jurisdictions currently are on previous code versions.

Buried ducts can still be implemented using a provision for alternative compliance.

- IRC R104.11 Alternative materials, design, and methods of construction and equipment
- Approval through a building official- typically building officials are friendly to options included in newer editions

Performance Path or ERI Compliance

The 2018 code, as described, enables reduced energy usage options that can be claimed toward compliance when using the Performance Path or the Energy Rating Index

Based on installation, this includes:

- A deeply buried R-8 duct, or portions of the duct which are buried can use an R-25 exposed duct when performance modeling
- A duct system that is covered with sufficient attic insulation and leaks less than 1.5 cfm/100ft2 may model the ducts in conditioned space.

Energy Simulations Using the Performance Path and ERI

Configuration	Energy Rating Index Path		IECC Performance Path	
	A	B	A	B
Attic Exposed (R-8 exposed, 4% leakage)	68	71	0%	0%
Buried Ducts (eff R-25 exposed, 4% leakage)	66	69	2%	3%
Buried Ducts (eff R-25 exposed, 3% leakage)	65	68	4%	4%
Buried Ducts (eff R-25 exposed, 2% leakage)	64	67	6%	6%
Buried Ducts (eff R-25 exposed, 1% leakage)	63	67	8%	7%
Buried Ducts (eff R-25 exposed, 0% leakage)	62	66	10%	8%
Ducts In Conditioned Space (testing exemption)	62	68	-6%	-3%
Ducts In Conditioned Space (tested 0 leakage)	62	64	-2%	-3%

Note: REScheck does not model duct performance

Conclusions

The 2018 IECC has changes that will specifically allow buried ducts

Code changes also give energy efficiency credit for deeply buried ducts- around 3% or 2 ERI points

Properly installed ducts can be considered “in conditioned space” which works in the ERI path, however, caution should be used when considering this option in the performance path. It may be beneficial to consider the ducts outside conditioned space.

Need to consider the delivery temperature will be lower with an increased condensation potential at the register boot.

Thank You.

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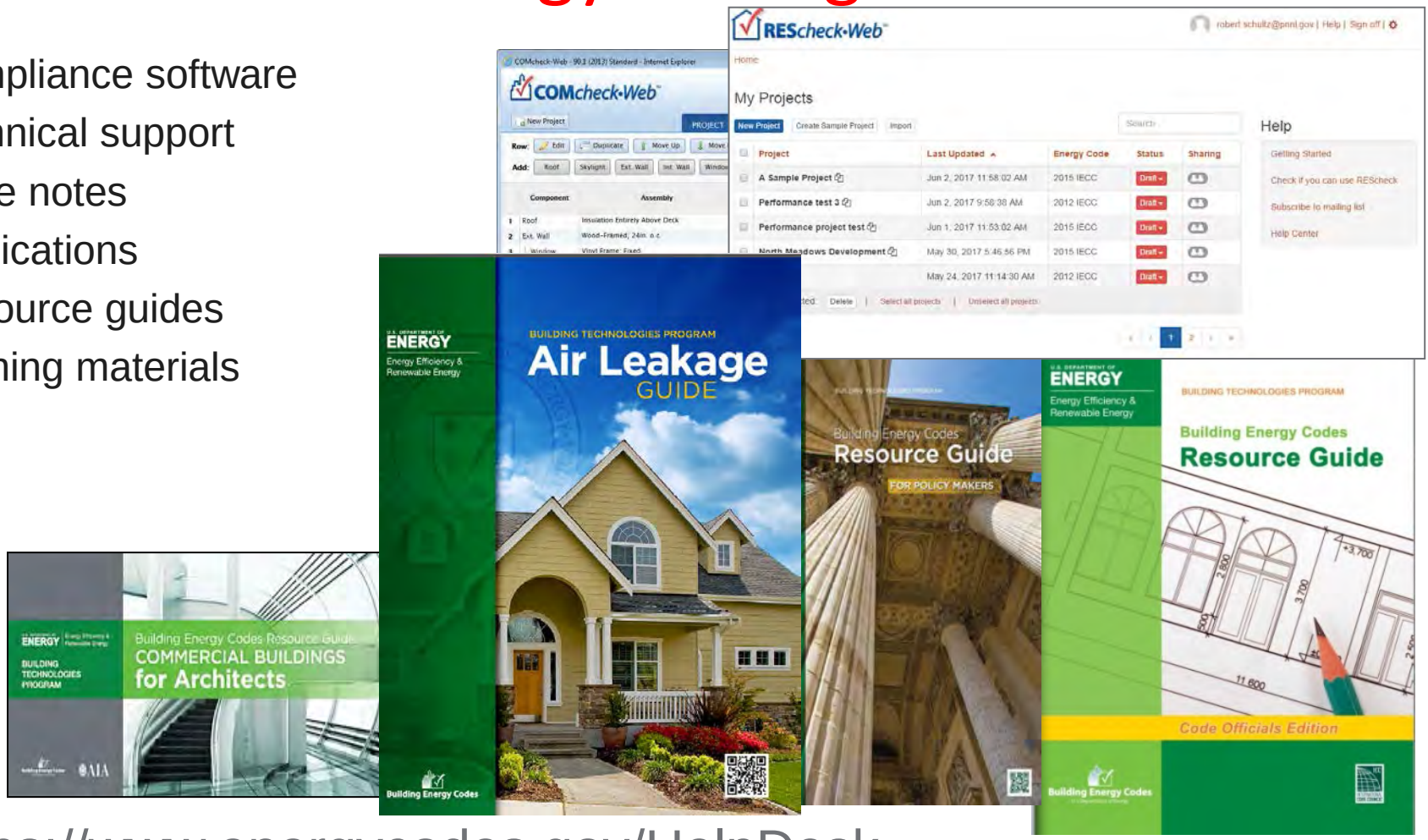

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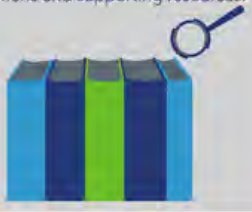

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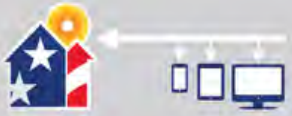

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CAD image for roof pipe penetration water and air sealing details
CAD File Posted: May, 2017
A ducted central return brings air from central return registers back to the air handler through insulated, air-sealed ducts
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Buried Ducts within Ceiling Insulation of Vented Attics in all Climate Zones - Code Compliance Brief

Overview:

The intent of this brief is to provide code-related information about buried ducts in vented attics to help ensure that the measure will be accepted as being in compliance with the code. Providing notes for code officials on how to plan review and conduct field inspections can help provide jurisdictional officials with information for acceptance. Providing the same information to all builders, designers, and others is expected to result in increased compliance and fewer innovations being questioned at the time of plan review and/or field inspection.

Plan Review:

lists the applicable code requirements and details helpful for plan review regarding the provisions to meet the requirements for "buried ducts in vented attics in hot-humid and mixed-humid climates."

Per the ***2015 IECC/IRC, Section R103.3/R106.3 Examination of documents***. The code official/building official must examine, or cause to be examined, construction documents for code cor

2015 IECC/IRC, Section R103.2/N1101

- Duct design specifications and lay designs)
  - Completed ACCA Manual J heati including duct area, duct leakag R-value. Current software calcu therefore, the designer should c less than a typical duct layout d R-value. For more information,
  - ***Section R302.1/N1101.9, Interior De*** should be a maximum of 72°F (22°C) for heating and m
    - Completed ACCA Manual D fo
    - Completed ACCA Manual T for
    - Completed ACCA Manual S fo
- Specified R-values of duct insulati depending on climate zone) and se

Field Inspection:

Per the ***2015 IECC, Sectio 104 Inspections***, construction or work for which a permit is required is subject to inspection. Construction or work is to remain accessible and exposed for inspection purposes until approved. Required inspections include footing and foundation, framing and rough-in, plumbing rough-in, mechanical rough-in, and final inspection.

R104.2.4 Mechanical Rough-In Inspection. Inspections at mechanical rough-in shall verify compliance as required by the code and approved plans and specifications as to installed duct system, insulation and corresponding R-values, system air leakage control, and testing. Because the duct system should be installed at the ceiling and then the attic insulation applied over the top of the ducts, this inspection might also include the inspection of the attic sealing and insulation R-values and insulation installation at the same time or performed at final inspection.

In the ***IRC, Section R109 Inspections***, the wording is somewhat different in that for onsite construction the building official, upon notification from the permit holder or his agent, can make, or cause to be made, any necessary inspections. Further details are provided for inspections regarding foundation, plumbing, mechanical, gas and electrical, floodplain, frame and masonry, and final inspections. Any additional inspections are at the discretion of the building official.

This section provides details for inspecting to the specific provisions for buried ducts in vented attics where one or more specific types of inspection per the IECC or IRC may be necessary to confirm compliance. Verifying code compliance would typically be at the mechanical rough-in and final inspection.

Inspections should provide verification in the following areas:

- Verify that joints and seams in ductwork are properly sealed, and the duct tightness report is complete and has been submitted per jurisdictional requirements. If ducts are employed, verify that duct insulation is installed in accordance with manufacturer's installation instructions and that the manufacturer's R-value mark is readily available and meets the approved R-value specified in construction documents.
- Verify that joints, seams, holes, and penetrations are caulked, gasketed, weather-stripped, or otherwise sealed.
- Ensure that the appearance of the installed ceiling insulation matches that specified in the approved construction documents.
- If the R-value or U-factor approach for compliance was used in the documentation, ensure that the installed insulation meets the minimum R-value or maximum U-factor required for the ceiling and climate zone per the approved construction documents.
- Ensure that the continuous air barrier is properly installed. Confirm that the air barrier is aligned with the insulation in any dropped ceiling/soffit and sealed.

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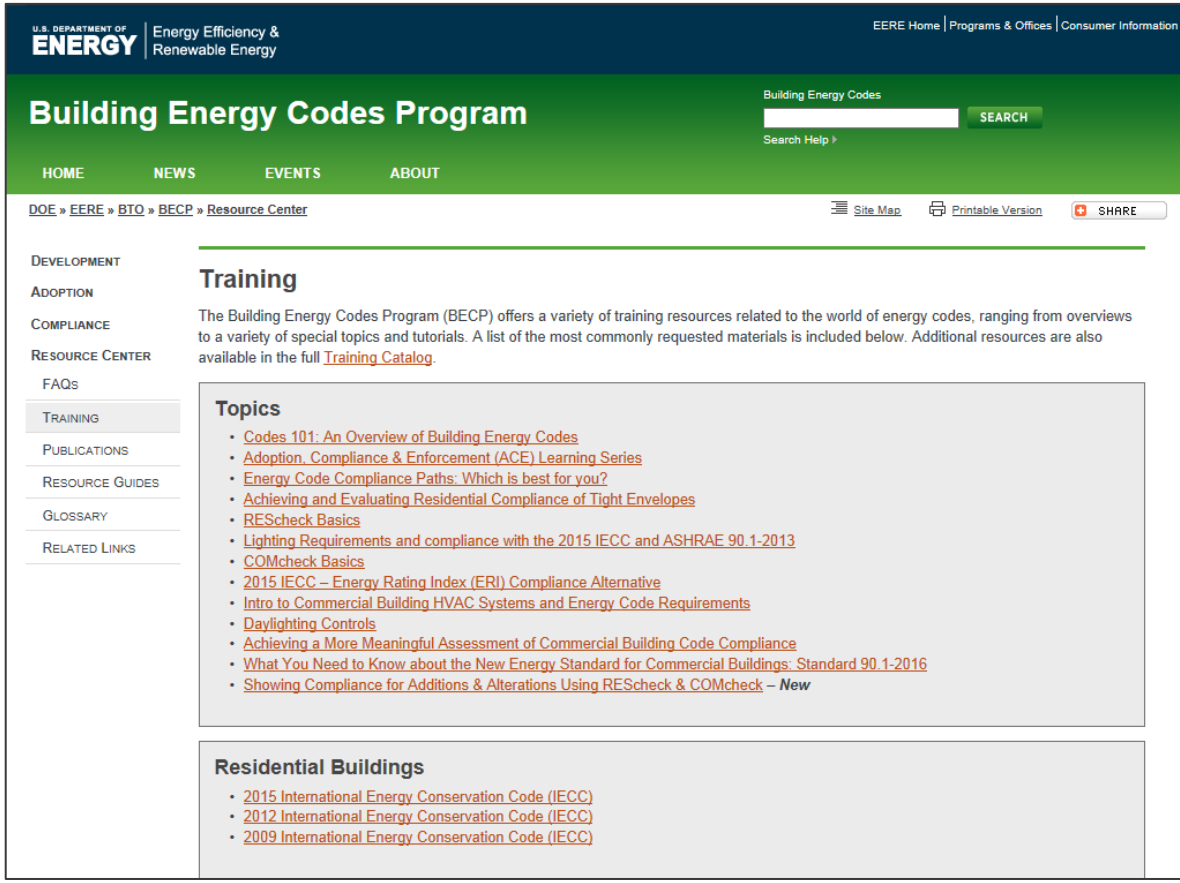

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