

Proposal Summary



Single Family Buried Ducts and Cathedral Ceilings

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Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that was discussed during a utility-sponsored stakeholder meeting on February 14, 2023. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by May 31 2023.

Measure Descriptions

Buried duct mandatory and prescriptive measures: Proposes to remove mandatory and prescriptive requirements for roof deck insulation in Climate Zone 16 and add prescriptive requirements under Option B for Climate Zones 1-3, 5-7, and 16 which include R-49 ceiling insulation (except R-60 in Climate Zone 16) and R-6 attic ducts fully buried in ceiling insulation. A prescriptive requirement for attic radiant barriers would be added to Climate Zones 1 and 16. The mandatory requirement for R-4 roof deck insulation would be eliminated if ducts are buried. Additional features of the proposal are as follows:

1. Compliance software would be modified to only require entering the largest diameter duct and insulation depth, rather than the currently required detailed entry of duct R-values, diameters, and lengths for each duct segment. The software would calculate duct heat transfers using updated effective R-values and standard assumptions of duct surface area based on nominal system size.
2. A layout of the duct design that is based on ACCA Manual D or similar calculations would be required to be provided with the Certificate of Compliance as required by RA3.1.4.1.1.3.
3. The new buried duct prescriptive approach would not require verification of the diameter, length, and R-value of each duct segment, only that the outside diameter of the largest duct is equal to or less than the attic insulation depth.

- Small houses ($\leq 500 \text{ ft}^2$) would be exempt from the prescriptive buried duct requirement but must provide increased attic insulation.
- Performance-based compliance using the proposed simplified buried duct compliance method would be available for use in all climate zones and could be used as a slightly lower performing alternative to high performance attics in Climate Zones 4 and 8-15 that also eliminates the mandatory requirement for R-4 roof deck insulation in those zones.
- The existing detailed duct design method for buried ducts would be retained and would reference ACM tables with significantly improved effective R-values.

Prescriptive code requirements for cathedral (vaulted) ceilings: Proposes to add a new prescriptive option for constructing cathedral ceilings – otherwise known as vaulted ceilings, cathedral roofs, or rafter roofs – that would require a maximum assembly U-factor of 0.032 in Climate Zones 11, 14, and 16, a U-factor of 0.026 in Climate Zones 1, 2, 4, 8 through 10, 12, 13, and 15, and a U-factor of 0.020 in Climate Zones 3 and 5 through 7. These U-factors are equivalent to cavity insulation of R-30, R-38, and R-49, respectively. In addition, projects following this prescriptive path would be required to locate ducts in conditioned space and comply with low leakage duct requirements. Other information related to this proposal is provided below:

1. A cathedral ceiling is defined as an assembly created when applying the ceiling directly to the underside of the roof framing members and applying structural roof sheathing directly to the top of the roof framing members. It may be flat or sloped and vented or unvented.
2. Insulation can be placed within the cavity or above the roof deck to meet the prescriptive U-factors.
3. Insulation values are based on equivalency to Option B of Table 150.1-A of the Title 24, Part 6 Standards, and include the increased stringency proposal of the buried duct measure.

Data Needs/Stakeholder Information Requests

Data needs include:

- **Energy Savings**
 - Do you perceive that burying ducts is an effective way to improve the efficiency of distribution systems or a viable alternative to insulating roof decks?
 - Are there case studies where the impact on system efficiency has been evaluated for buried ducts (other than those cited in the CASE Report)?
- **Technical Feasibility**

- What are the challenges of designing for and installing smaller diameter ducts that can be fully buried?
- What are the prevalent methods used to size residential HVAC systems and ducts? For example, are ducts sized based on room-by-room thermal load calculations or other methods?
- Are most HVAC designers or Title 24 consultants well versed in ACCA design methods (Manuals J, S, and D)?
- Are there any local codes or building jurisdictions that require that ducts be suspended?
- What information is available about the lifetime of flex ducts? Will they last longer if buried in insulation?
- Are raised-heel trusses necessary when R-49 or thicker insulation is installed?
- Is it common to run ducts through cathedral ceiling spaces?
- Will it be any more difficult to provide zoning with buried duct systems?
- **Market Readiness**
 - How common is it to install buried ducts?
 - How receptive are HVAC designers, compliance consultants, contractors, and builders to the concept of buried ducts?
 - What impact will simplifying compliance and verification procedures have on improving the market for buried ducts?
- **Costs**
 - Will the cost of materials and/or labor be greater or less for buried vs. suspended ducts?
 - What are the additional material and labor costs associated with raised heel trusses?
 - What are the differences in cost between traditional trunk/branch vs. radial duct design?
- **Economic Impacts**
 - Will installation of buried ducts and higher insulation R-values require higher trade skills?
 - Given expected incremental costs, will it be cost-effective to install buried ducts?

Data may be provided anonymously. To participate or provide information, please email Simon Palin, spallin@frontierenergy.com directly and cc info@title24stakeholders.com.

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2022 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions).

Standards

SUBCHAPTER 7 – SINGLE-FAMILY RESIDENTIAL BUILDINGS – MANDATORY FEATURES AND DEVICES

Section 150.0 – Mandatory Features and Devices

- (a) **Roof deck, ceiling and rafter roof insulation.** The opaque portions of roof decks separating attic spaces from ambient air, and ceilings or rafter roofs separating conditioned spaces from unconditioned spaces or ambient air, shall meet the requirements of Items 1 through 4 below:
1. In Climate Zones 4 and 8 through ~~1546~~, roof decks in newly constructed attic systems shall be insulated to achieve an area-weighted average U-factor not exceeding U-0.184.

Exception to Section 150.0(a)1:

- i. The space-conditioning system air handler and ducts are located entirely in conditioned space below the ceiling separating the occupiable space from the attic; or
- ii. The space-conditioning system air handler and ducts are located entirely in conditioned space and has 12 linear feet or less of supply duct, including the length of the air handler and the plenum, located in unconditioned space, with all other portions of the supply ducts located in conditioned space below the ceiling separating the occupiable space from the attic; or
- iii. The space-conditioning system air handler is located in a vented attic with a radiant barrier that meets the requirements specified in Section 110.8(j), and shall meet the installation criteria specified in the Reference Residential Appendix RA4, air handler leakage shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9, and ducts shall be fully buried in loose fill ceiling insulation and confirmed by field verification to meet the criterion of Reference Residential Appendix Sections RA3.1.4.6 and RA3.1.4.9.

SUBCHAPTER 8 – SINGLE-FAMILY RESIDENTIAL BUILDINGS – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES

SECTION 150.1(c) – Prescriptive standards/component packages

1. Insulation.

- A. Roof and ceiling insulation shall be installed in a ventilated attic with an R-value equal to or greater than or a U-factor equal to or less than that shown in Table 150.1-A meeting options ii, ~~or~~ iii, or iv below.

- i. Option A: **RESERVED**.
- ii. Option B: In Climate Zones 4 and 8 through 15 a minimum R-value of insulation installed between the roof rafters in contact with the roof deck and an additional layer of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9A. In Climate Zones 1 through 3, 5 through 7, and 16 a ventilated attic with a minimum R-value of ceiling insulation located between the attic and the conditioned space and space conditioning system that complies with Section 150.1(c)9C; or
- iii. Option C: A minimum R-value of ceiling insulation located between the attic and the conditioned space when meeting Section 150.1(c)9B; or and space conditioning system complies with Section 150.1(c)9B; or
- iv. Option D: A cathedral ceiling with a maximum U-factor or a minimum R-value of cavity insulation and space conditioning system complies with Section 150.1(c)9B.

~~**Note:** Low rise residential single-family buildings with the ducts and air handler located in the conditioned space, as specified by Section 150.1(c)9B, need only comply with insulation requirements of Option C.~~

9. Space conditioning distribution systems. All space conditioning systems shall meet all applicable requirements of A, B, or BC below:

- A. **High performance attics.** Air handlers or ducts are allowed to be in ventilated attic spaces when the roof and ceiling insulation level meet Option B in Table 150.1-A. Duct insulation levels shall meet the requirements in Table 150.1-A.
- B. **Duct and air handlers located in conditioned space.** Duct systems and air handlers of HVAC systems shall be located in conditioned space, and confirmed by field verification and diagnostic testing to meet the criterion of Reference Residential Appendix Section RA3.1.4.3.8. Duct insulation levels shall meet the requirements in Table 150.1-A.
- C. **Buried ducts.** Air handlers and ducts are allowed to be in ventilated attic spaces when the following conditions are met.
 - i. All supply ducts are fully buried in loose fill ceiling insulation and confirmed by field verification and diagnostic testing to meet the criterion of Reference Residential Appendix Section RA3.1.4.1.9.
 - ii. Nominal duct R-values, ceiling insulation R-values, and radiant

barriers shall meet the requirements in Table 150.1-A.

Exception 1 to Section 150.1(c)9C: Residential buildings having a conditioned floor area of 500 ft² or less may meet the requirements of Table 150.1-B.

Proposed changes to the prescriptive requirements in Table 150.1-A:

	Climate Zone						
	1	2	3	5	6	7	16
Current¹							
Roof Deck Insulation	NR	NR	NR	NR	NR	NR	R-19
Ceiling Insulation	R-38	R-38	R-30	R-30	R-30	R-30	R-38
Radiant Barrier	NR	REQ	REQ	REQ	REQ	REQ	NR
Ducts	R-8	R-8	R-6	R-6	R-6	R-6	R-8
Proposed¹							
Roof Deck Insulation	NR	NR	NR	NR	NR	NR	NR
Ceiling Insulation	R-49	R-49	R-49	R-49	R-49	R-49	R-60
Radiant Barrier	REQ	REQ	REQ	REQ	REQ	REQ	REQ
Ducts²	R-6	R-6	R-6	R-6	R-6	R-6	R-6

Table Notes:

1. Applies to Option B only.
2. For each of these climate zones ducts must be fully buried in ceiling insulation in accordance with the exception added to Section 150.1(c)1A and the added Section 150.1(c)9C covering buried duct requirements.

**Proposed ceiling insulation requirements for residential buildings 500 ft² and smaller
(Buried Ducts not required)**

Climate Zone	Attic Insulation
1 through 3	R-49
5 through 7	R-38
16	R-60

Reference Appendices

The many changes to the Reference Appendices are summarized below. The complete language will be provided with the Draft CASE Report in June.

- RA3.1.4.5 is renamed “Verification of Buried Ducts for Compliance Credit – Detailed Method”. It retains the current verification requirements but changes the minimum duct R-value from R-4.2 to R-6.
- RA3.1.4.1.6, “Verification of Deeply Buried Ducts R-Value” will be eliminated.

- RA3.1.4.6 which requires verification of Bypass Ducts in zonally controlled systems will also be used to verify that zone dampers will be accessible for service if installed with buried duct systems (not buried).
- RA3.1.4.9 titled “Verification of Buried Ducts for Prescriptive and Performance Compliance – Simplified Method” would be added. It requires:
 - Duct System Design Layout – a scaled drawing of the duct system. This language is identical to that required under RA3.1.4.5.
 - Buried Duct Design Method – design documentation using ACCA Manual D or an equivalent method. This is also the same requirement that exists in RA3.1.4.5, is mandatory under Title 24 Part 11, and would be required under the 2025 HVAC CASE report.
 - Field verification of duct sealing and leakage testing would take place during rough-in with ducts attached to the air handler. The basis for duct leakage can be either nominal air handler airflow (350 cfm/ton) or measured.
 - Not more than three feet of each duct would be allowed to be above ceiling insulation to provide for connection to the air handler plenum. This would be verified.
 - Current requirements for signage and duct location markers (every 8 feet) are retained. This is important to minimize the risk of damage if work is being done in the attic after insulation is installed.
 - Following installation of attic insulation current requirements for inspecting duct connections and seals between registers and ceiling drywall were retained.
 - An additional inspection to verify that all ducts are covered by insulation is added, but the current requirement for QII would not be required on the theory that if the largest diameter duct is covered that the depth of insulation is very likely to be at least the R-49 required (R-60 in Climate Zone 16).
- The following table is provided to help builders, HVAC installers, and insulators understand how much insulation is required to fully cover ducts with fiberglass or cellulose. R-49 or R-60 insulation would be *prescriptively* required in Climate Zones 1-3, 5-7, and 16, but the table is useful for guiding the design of partially covered and fully covered duct designs when applied for performance credit. ACM Reference Manual tables listing effective R-values for partially and fully covered ducts that are used in compliance software will be updated to include higher effective R-values than currently listed.

To achieve full coverage of R-8 ducts requires more insulation than R-6 ducts because of the larger outside diameter of the R-8 ducts. Table values conservatively assume that ducts are installed over 3.5 inch trusses though they may be laid over ceiling drywall to achieve a higher effective R-value.

Attic Insulation Depth and Maximum Duct Diameter Required to Fully Cover Ducts

Attic Insulation R-Value	Attic Insulation Depth ¹ (inches)		Maximum Diameter of R-6 Ducts (inches)		Maximum Diameter of R-8 Ducts (inches)	
	Fiberglass	Cellulose	Fiberglass	Cellulose	Fiberglass	Cellulose
30	12.0	8.8	4		3	
31	12.4	9.1	4		3	
32	12.8	9.4	5		4	
33	13.2	9.7	5		4	
34	13.6	10.0	6		5	
35	14.0	10.3	6		5	
36	14.4	10.6	6	3	5	
37	14.8	10.9	7	3	6	
38	15.2	11.2	7	3	6	
39	15.6	11.5	8	4	7	3
40	16.0	11.8	8	4	7	3
41	16.4	12.1	8	4	7	3
42	16.8	12.4	9	4	8	3
43	17.2	12.6	9	5	8	4
44	17.6	12.9	10	5	9	4
45	18.0	13.2	10	5	9	4
46	18.4	13.5	10	6	9	5
47	18.8	13.8	10	6	10	5
48	19.2	14.1	10	6	10	5
49 ²	19.6	14.4	12	6	10	5
50	20.0	14.7	12	7	10	6
51	20.4	15.0	12	7	10	6
52	20.8	15.3	12	7	12	6
53	21.2	15.6	12	8	12	7
54	21.6	15.9	14	8	12	7
55	22.0	16.2	14	8	12	7
56	22.4	16.5	14	9	12	8
57	22.8	16.8	14	9	14	8
58	23.2	17.1	14	9	14	8
59	23.6	17.4	16	9	14	8
60 ³	24.0	17.6	16	10	14	9

¹Based on R-value of 2.5 per inch for fiberglass and settled R-value of 3.4 per inch for cellulose.

²Prescriptively required in Climate Zones 1-3 and 5-7

³Prescriptively required in Climate Zone 16