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June 2nd, 2021

California Energy Commission
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Dear Commissioners,

Re: Docket Number 21-BSTD-01 2022 Energy Code Update Rulemaking

Section 150.0(m)1B of the "Express Terms 2022 Energy Code, Title 24 Parts 1 and 6", published to this docket on 5/6/2021, contains restrictions on the use of uninsulated ducts in conditioned space that are more onerous than the restrictions in the 2019 Energy Code.
Section 150(m)1B of the 2019 Energy Code concerns insulation on ducts in residential buildings:

Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to:
i. a minimum installed level of R-6.0, or
ii. a minimum installed level of R-4.2 when the duct system is located entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.

Exception 1 to this section covers duct in wall cavities:

Portions of the duct system located in wall cavities are not required to be insulated if the following conditions are met:
i. The cavity, duct or plenum is located entirely inside the building's thermal envelope as confirmed by visual inspection.
ii. At all locations where portions of non-insulated cavities, ducts, or plenums make a transition into unconditioned space, the transition shall be air-sealed to prevent air infiltration into the cavity and be insulated to a minimum of R-6 as confirmed by visual inspection.

Portions of the duct system which are completely exposed and surrounded by directly conditioned space are not required to be insulated (Exception 2)

The proposed text for the 2022 Energy Code lowers the insulation required for ducts in conditioned, while limiting the cases in which the exception applies (the added text is *italicized* below):

Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall either be insulated to:
i. a minimum installed level of R-6.0, or
ii. a minimum installed level *as specified in subsections a or b below* when the duct system is located entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.

a. R-1 for ducts with a surface emissivity greater than or equal to 0.8.
b. R-3 for ducts with a surface emissivity less than 0.8.

EXCEPTION 1 to Section 150.0(m)1B: Portions of the duct system located in wall cavities are not required to be insulated if all of the following conditions are met:
i. The cavity *containing the non-insulated portion of the duct system* is located entirely inside the building's thermal envelope as confirmed by visual inspection.
ii. The non-insulated portion of the duct system has outer cross-sectional dimensions that are within 0.25 inch of the inner cross-sectional dimensions of the cavity.
iii. At all locations where *non-insulated* portions of *the* duct *system*, or plenums make a transition into unconditioned space, the transition is air-sealed to prevent air infiltration into the cavity and insulated to a minimum of R-6 as confirmed by visual inspection.

Ducts in conditioned space are inherently more energy efficient than ducts outside conditioned space, as any 'loss' of conditioned air is to conditioned space and is therefore not actually lost to the building. The Energy Commission's compliance software (CBECC-Res) recognizes this by not modeling any losses from duct systems located in conditioned space.
The use of ducts in conditioned space presents a design challenge to builders due to the size of the ducts. Typically, dropped ceilings in hallways, or soffits are the most common methods used to conceal insulated ducts. Uninsulated ducts are inherently narrower than insulated ducts with the same interior diameter, which allows their use in cavities which would not be able to contain insulated ducts, such as walls or ceilings/floors between stories. This provides increased options for designers and builders to create duct systems within the building's thermal envelope. Increasing the usability of air distribution systems with uninsulated ducts would lead to an increase in the use of ducts in conditioned space, which would in turn lead to statewide energy savings. The proposed changes to the Energy Code would reduce these savings.

In the Energy Commission's "Initial Statement of Reasons", the motivation for these changes is given:

"These changes are necessary to ensure that required R-values are not more stringent than needed to provide expected benefits, and to ensure that associated exceptions are not overly broad. Insulation has a reduced value when the associated ducts are transiting through conditioned spaces, as any heat or cooling "lost" via attenuation is still delivered into an indoor space. Insulation is still necessary to prevent condensation and to prevent distant rooms from being under-served and requiring more extreme thermostat settings (with associated additional energy use) to achieve temperatures matching those of rooms that are nearer to the source of heating or cooling."

It is ConSol's position that these changes are overly restrictive for the following reasons:

1. Attenuation

It is true that there will be more heat exchange between air inside and outside the duct if the duct is uninsulated than there would be if it were insulated. This attenuation would not, however, lead to any additional energy use as the conditioning would be delivered to the conditioned space and not lost to outside or unconditioned space. The issue of distant rooms being underserved due to this attenuation

should not be seen as a reason to restrict the use of uninsulated ducts: all duct systems will suffer losses due to attenuation and this can, and should, be accounted for by proper design and balancing.

2. Condensation

Condensation will occur on surfaces that are below the dew point of the surrounding air. The issue is whether the quantity of liquid condensed on a surface will be sufficient to become a problem. A recent report[1] by the Western Cooling Efficiency Center (WCEC) at UC Davis analyses this question detail for all of California's 16 Climate Zones. The conclusions of this analysis are:

- Condensation in the worst-case scenario is for a very leaky cavity (modeled as having a 5/8 of an inch diameter hole in each end of the cavity) in the climate zone with most likelihood of condensation amounts to 0.076lbs of water (0.7 teaspoons). This would be equivalent to a change in the moisture content of the wood studs in the cavity of 0.06%. The cyclical nature of the condensation, which evaporates when the cooling systems is off, would not result in an accumulation of liquid.
- Horizontal cavities have approximately ½ the condensation of vertical cavities
- Modeling the ducts as less leaky (with 1/3 of an inch diameter holes) reduces the condensation by approximately ½
- Modeling the ducts as airtight reduces the modeled condensation by approximately 90%

It should be noted that the analysis in the WCEC report is designed to give conservative data: the duct emissivity is modeled as 0, which will result in the maximum condensation possible. Additionally, the report compares the modeled indoor dewpoints with measured data from a study of actual houses and finds that the models are likely over-estimating indoor dewpoint temperatures. This would lead the models to over-estimate the degree of condensation.

ConSol believes that it is reasonable to conclude from this analysis that condensation on uninsulated ducts in conditioned space is not an issue that needs regulation by the Energy Commission. The level of condensation that can be expected is no more than might be seen on, for example, cold water pipes, which are not required to be insulated. The thickness of the layer of condensation that could be expected in the worst-case scenario for this analysis is 0.2 thousandths of an inch. This thickness is too low to allow for beading and there is therefore no possibility of the condensation pooling to create moisture damage. Further, any duct material is required to meet the standards of UL 181 which covers resistance to mold growth.

Insulating ductwork has a cost in both materials and labor. Requiring insulation which provides no energy benefits is contrary to the Warren-Alquist Act. The use of uninsulated ducts in cavities in conditioned space is allowed under the International Residential Code (section N1103.3.1), the International Energy Conservation Code (R403.3.1), and every state building code in the United States, including the current California Code. To impose tighter restrictions on their use in the 2022 Energy Code without evidence of likely harm is damaging to the State's energy efficiency goals. To allow the use of uninsulated ducts while minimizing the concerns surrounding condensation, it would be logical to amend the current code to ensure that any cavity containing an uninsulated duct

[1] https://title24stakeholders.com/measures/cycle-2022/analysis-of-duct-insulation-requirements-for-ducts-in-conditioned-and-indirectly-conditioned-spaces/

should be reasonably well sealed, by amending the current language to allow ducts in cavities and require a visual inspection of any penetrations into such cavities.

ConSol therefore recommends that section 150.0(m)1B of the 2019 code be amended for the 2022 code to read as follows (changes are noted in *red italic* text):

"Portions of supply-air and return-air ducts and plenums of a space heating or cooling system shall ~~*either*~~ be insulated to~~*i*~~. a minimum installed level of R-6.0~~*, or*~~
~~*ii. a minimum installed level of R-4.2 when the duct system is located entirely in conditioned space as confirmed through field verification and diagnostic testing in accordance with the requirements of Reference Residential Appendix RA3.1.4.3.8.*~~

EXCEPTION 1 to Section 150.0(m)1B: Portions of the duct system located in wall cavities*, ceiling cavities, floor cavities, soffits, chases, or plenums* are not required to be insulated if the following conditions are met:
i. The cavity, duct or plenum is located entirely inside the building's thermal envelope as confirmed by visual inspection.
ii. At all locations where portions of non-insulated cavities, ducts, or plenums make a transition into unconditioned space, the transition shall be air-sealed to prevent air infiltration into the cavity and be insulated to a minimum of R-6 as confirmed by visual inspection. *Any other penetration into a cavity containing a duct shall be caulked, gasketed, or otherwise sealed to limit infiltration and exfiltration.*

EXCEPTION 2 to Section 150.0(m)1B: Portions of the duct system completely exposed and surrounded by directly conditioned space are not required to be insulated."

On behalf of ConSol I would like to take this opportunity to thank Energy Commission staff for their ongoing co-operation and assistance on this topic.

Sincerely,

William Allen, PhD
Senior Technical Consultant
CONSOL