

TECHNICAL BULLETIN

No: TB57 November 1, 2024

How Pipe and Duct Insulation Meets Energy Codes

There are two model energy efficiency standards for commercial buildings:

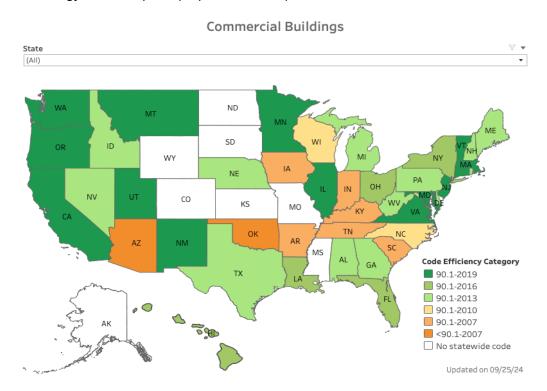
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - ANSI/ASHRAE/IES Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
- International Code Council[®] (ICC[®])
 - o International Energy Conservation Code® (IECC®)

Both standards specify minimum requirements for energy efficiency and are updated in 3-year cycles. The most current versions are ASHRAE 90.1-2022 and IECC-2024.

It's important to understand that these standards must be adopted by states and/or local jurisdictions to become model codes.

Commercial construction projects are often designed based on ASHRAE 90.1 as a compliance path for the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) certification.

However, most states adopt a version of the IECC and periodically update to improve energy efficiency. Below is the status of state energy code adoption (September 2024).



The *Minimum Piping Insulation Thickness* per ASHRAE 90.1-2022 and IECC-2024 are detailed below.

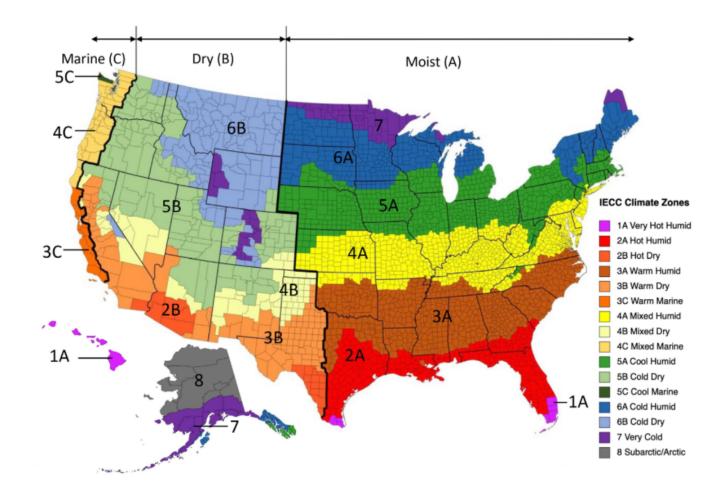
	TABLE 6.8.3	3-1 Minimum Pipin	g Insulation	Thickness (AS	HRAE 90.1-202	2)	
	TABLE (403.13.3 Minimun	n Pipe Insula	tion Thicknes	s (IECC-2024)		
		Heating a	nd Hot Wate	er Systems			
(Steam, Steam	Condensate, Hot	Water Heati	ng and Domes	tic Water Syste	ems)	
				Nominal Pipe or Tube Size (in)			
Line Temp (°F)	Thermal k	Mean Temp (°F)	<1	1 to < 1-1/2	1-1/2 < 4	4 to < 8	>8
			M	Minimum Insulation Thickness (in) or R-Value			
>350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
			R-32	R-36	R-34	R-26	R-21
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
			R-20	R-29	R-32	R-24	R-20
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
			R-17	R-17	R-17	R-15	R-13
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
			R-9	R-9	R-11	R-10	R-9
105-140	0.22-0.28	100	1.0	1.0	1.5	1.5	1.5
			R-5	R-9	R-8	R-8	R-7
		TABLE 6.8.3-2 Min	imum Pipe I	nsulation Thic	kness		
	Coo	ling Systems (Chille	ed Water, Br	ine and Refrig	erant)		
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
			R-2	R-2	R-5	R-5	R-4
<40	0.22-0.26	50	0.5	1.0	1.0	1.0	1.5
			R-6	R-9	R-9	R-8	R-7

<u>Note:</u> Although the minimum piping insulation thicknesses remain unchanged, IECC added minimum R-Values to the 2024 code as "an option" to achieve energy conservation. Either minimum insulation thickness <u>OR</u> minimum R-value can be selected. ASHRAE 90.1 will add R-values in the next update scheduled for 2025.

Minimum Duct Insulation Thickness is specified by R-Value depending on the climate zone of the project location in the United States. Additionally, thickness is determined by the duct location on the project:

- ♦ Exterior (outside the building envelope)
- ♦ Unconditioned space (i.e. mechanical room)
- ♦ Indirectly conditioned space (i.e. spaces adjacent to conditioned spaces)

Below is the most current Climate Zone Map from IECC-2021.



The *Minimum Duct Insulation Thickness* per ASHRAE 90.1-2022 and IECC-2024 are detailed below.

ASHRAE 90.1-2022 Minimum Duct Insulation R-Value								
IECC-2024 C403.13.1 Duct & Plenum Insulation								
Climate Zone	Exterior	Unconditioned	Indirectly					
		Space and Buried	Conditioned					
		Ducts	Space					
Supply & Return Ducts for Heating & Cooling								
0 to 4	R-8	R-6	R-1.9					
5 to 8	R-12	R-6	R-1.9					
Supply & Return Ducts for Heating Only								
0 to 1	None	None	None					
2 to 4	R-6	R-6	R-1.9					
5 to 8	R-12	R-6	R-1.9					
Supply & Return Ducts for Cooling Only								
0 to 6	R-8	R-6	R-1.9					
7 to 8	R-1.9	R-1.9	R-1.9					

Energy codes do not specify insulation type -

The best pipe and duct insulation type for a given application should be selected based on characteristics such as:

- ♦ Composition (i.e. fibrous versus non-fibrous)
- ♦ Cell structure (i.e. closed cell versus open cell, rigid versus flexible)
- Operating temperature
- ♦ Thermal conductivity (k-value)
- Water vapor permeability (perm rating)
- ♦ Fire performance (25/50 flame & smoke developed indexes)
- ♦ Owner project requirements such as budget and sustainability (low-VOC, EPD, HPD)

Energy codes specify minimum insulation thickness or R-value for energy efficiency only -

- Insulating below-ambient piping & duct systems require special consideration such as condensation control and mold prevention.
- Chilled water and refrigerant piping are of particular concern. Closed-cell insulation with a vapor retarder (built-in or supplemental) is proven to provide the best long term performance by effectively controlling condensation.
- ♦ Greater thicknesses may be required to control condensation due to specific project operating environments such as low operating temperatures in high ambient and relative humidity conditions.

Important Takeaways

- Energy codes do not specify insulation type.
- Energy codes specify <u>minimum</u> insulation thickness or R-value for energy efficiency. Greater thickness may be required for condensation control.
- <u>Either</u> minimum insulation thickness <u>OR</u> minimum R-value meet the code. R-values have been added as an "optional" compliance path. Depending on the insulation type, the thickness may increase to meet minimum R-values.

To learn more about pipe insulation, click here.

To learn more about <u>duct</u> insulation click <u>here</u>.

Sources -

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https://shop.iccsafe.org/international-codes/iecc-references/2024-international-energy-conservation-coder.html

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https://basc.pnnl.gov/images/climate-zone-map-iecc-2021