

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

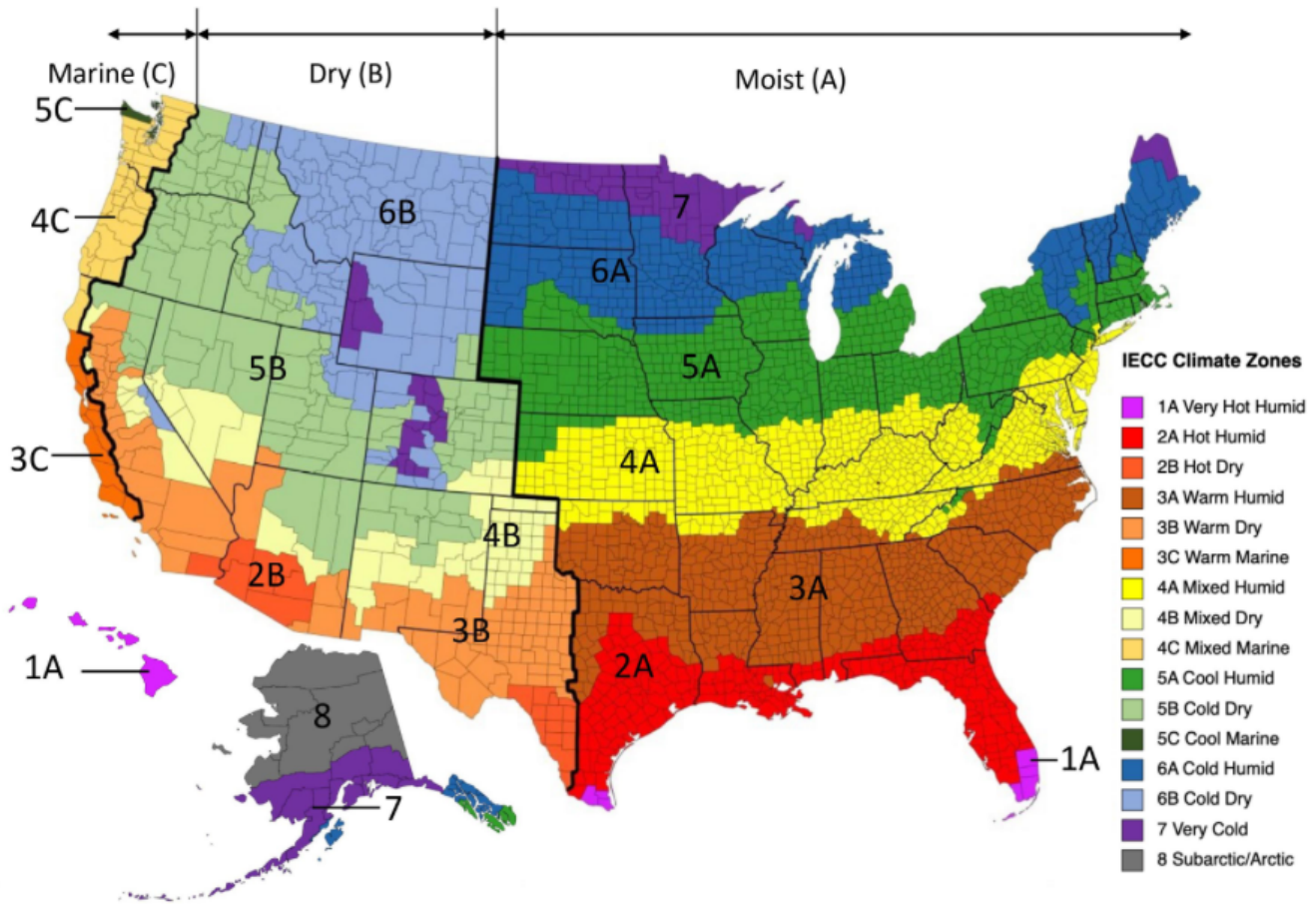
TABLE 6.8.3-1 Minimum Piping Insulation Thickness (ASHRAE 90.1-2022)							
TABLE C403.13.3 Minimum Pipe Insulation Thickness (IECC-2024)							
Heating and Hot Water Systems							
(Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems)							
Nominal Pipe or Tube Size (in)							
Line Temp (°F)	Thermal k	Mean Temp (°F)	< 1	1 to < 1-1/2	1-1/2 < 4	4 to < 8	> 8
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 Minimum Pipe Insulation Thickness							
Cooling Systems (Chilled Water, Brine and Refrigerant)							
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

Note: 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 OR 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 Space and Buried Ducts	Indirectly Conditioned 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 minimum insulation thickness or R-value for energy efficiency. Greater thickness may be required for condensation control.**
- **Either minimum insulation thickness OR 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 duct insulation click [here](#).

Sources -

<https://www.ashrae.org/technical-resources/bookstore/standard-90-1>

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

<https://www.energycodes.gov/state-portal>

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