

## BULLETIN: INSULATION FOR VRF BEING IMPROPERLY SPECIFIED TAILORED FOR CALIFORNIA TITLE 24

### OVERVIEW

Insulation is an often overlooked and misunderstood part of refrigerant piping systems, particularly VRF systems. Most engineering firms and contractors are not paying enough attention to insulation materials and thicknesses required from both manufacturers' installation instructions and energy codes.

- **Insulation requirements for VRF per 2016 California Title 24:**

The following are *minimum* insulation thicknesses:

- **Liquid lines:**

Line Size	Minimum Thickness
≤ 7/8"	1"
≥ 1-1/8"	1.5"

- **Suction lines (do not use fiberglass insulation):**

Line Size	Minimum Thickness
≤ 7/8"	1"
≥ 1-1/8"	1.5"

- **Hot-gas lines (may need to be thicker depending on refrigerant temperature):**

Line Size	Min Thickness	Notes
≤ 1-3/8"	1.5"	Also applies to small vapor lines supplying fan coil units
≥ 1-5/8"	2"	

- **Manufacturers' installation instructions:**

- Insulation required to be closed-cell elastomeric foam and must be rated for 248°F. **EPDM** insulation should be considered for its continuous high-temperature rating.
- Must also account for their minimum insulation thickness requirements.

- **Bonus – rebates for code compliance:**

- Newly passed "Inflation Reduction Act" offers significant tax deductions for meeting ASHRAE 90.1 standards.
  - Note: California Title 24 has thicker insulation requirements than ASHRAE 90.1

### INSULATION REQUIREMENTS FOR VRF PER 2016 CALIFORNIA TITLE 24

As shown in Table 120.3-A, California Title 24 requires minimum insulation thicknesses based on both the size of the tubing and the temperature of the refrigerant.

VRF liquid lines reach temperatures above 105°F during heating and require minimum 1" insulation thickness for line sizes 7/8" and below. Liquid lines sized 1-1/8" and larger require a minimum insulation thickness of 1.5".

VRF suction temperatures are very cold and can run near 32°F, especially if there are refrigerant charge issues or if the systems have any zones that are short on cooling, both of which drive down the entire system's suction temperatures. With temperatures this low, Title

24 requires suction lines to have minimum insulation thicknesses of either 1" or 1.5", depending on the line size.

*Note: In more humid areas of the country, even thicker insulation is needed on the suction lines to prevent condensation from forming. It is highly recommended that fiber glass insulation NOT be used on VRF as the suction temperatures are so cold. Fiber glass insulation relies on a single vapor seal at the surface, which nearly always get punctured and allows condensation on the lines. Closed-cell elastomeric foam has a continuous vapor barrier throughout the thickness and is a must on VRF cold piping.*

VRF hot gas lines are not as straight forward when it comes to Title 24 and insulation thicknesses. Hot gas lines for most VRF systems can operate at up to 239°F, but most manufacturers will state the "normal" operating temperature range between 141-200°F. Assuming a peak normal operating temperature of less than 200°F for the hot gas line, 1.5" is the minimum insulation thickness to be used on the hot gas lines up to 1-3/8" tubing size (larger lines require 2" minimum thickness). If the normal operating temperature exceeds 200°F, a minimum thickness of 2.5" should be used.

*Note: the vapor lines on the smaller line sets that supply the fan coil units have the same operating temperatures, and thus the same minimum insulation thickness requirement of 1.5" (or larger).*

**TABLE 120.3-A PIPE INSULATION THICKNESS**

FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot per °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)						
			< 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger		
			INSULATION THICKNESS REQUIRED (in inches)						
Space heating, Hot Water systems (steam, steam condensate and hot water) and Service Water Heating Systems (recirculating sections, all piping in electric trace tape systems, and the first 8 feet of piping from the storage tank for nonrecirculating systems)									
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0		
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5		
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0		
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0		
105-140	0.22-0.28	100	1.0	1.5	1.5	1.5	1.5		
Space cooling systems (chilled water, refrigerant and brine)									
40-60	0.21-0.27	75	Nonres 0.5	Res 0.75	Nonres 0.5	Res 0.75	1.0	1.0	1.0
Below 40	0.20-0.26	50	1.0		1.5		1.5	1.5	1.5

Table 120.3-A. Pipe Insulation Thickness chart from 2016 California Title 24.

## MANUFACTURERS' INSTALLATION INSTRUCTIONS

VRF manufacturers' installation instructions all specify their own minimum insulation thicknesses. While these manufacturer thickness minimums are typically smaller than California Title 24 requirements, the manufacturers' installation instructions should still be checked and considered.

All VRF manufacturers require the piping insulation to be closed-cell elastomeric foam with a temperature rated for at least 248°F. While 248°F is the safety shut off temperature for most VRF systems, they can still operate near 248°F for long periods when systems have refrigerant charge issues, even in mild climates. This is important as most piping insulation materials such as NBR rubber and polyethylene (PE) can fail at these temperatures. These insulations will either 1) shrink and tear open the glued seams and butt joints, 2) destroy the cellular structure of the elastomeric foam and crumble, or 3) simply melt. Many of these failing insulation materials publish **intermittent** temperature ratings of up to 248°F, but their

continuous rating is typically much lower. Attention to this issue is critical. The ideal insulation material for VRF systems is EPDM (Ethylene Propylene Diene Monomer). EPDM is a rubber-based, closed-cell elastomeric foam having **continuous** max temperature ratings of at least 257°F. The product is manufactured domestically by several well-known manufacturers and is readily available.

*Note: EPDM should also be considered on the lines supplying the fan coil units as they have the same 248°F requirement.*

## **BONUS – REBATES FOR CODE COMPLIANCE**

The newly passed Inflation Reduction Act offers significant 179D tax deductions when the current ASHRAE 90.1 standards are met. All Architects and building owners need to be aware of this new rebate.

*Note: California Title 24 has thicker insulation requirements than ASHRAE 90.1.*

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