

2016 CALIFORNIA TITLE 24 REQUIREMENTS FOR PIPE INSULATION FOR VARIABLE REFRIGERANT (VRF/VRV) HEATING / COOLING SYSTEMS

INTRODUCTION

For California, requirements for pipe insulation is mandated in the 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. **Section 120.3 – Requirements for Pipe Insulation** and **Table 120.3-A** set prescriptive standards for insulation thickness. This section and table determine insulation thickness based on type of system (Space Cooling, Space Heating, or Service water-heating) and the fluid temperature range.

SECTION 120.3 – REQUIREMENTS FOR PIPE INSULATION

For VRF/VRV systems, this section specifically requires insulation for;

1. Space Cooling Systems, and
2. Space Heating Systems

Item 1, “**Space Cooling Systems.** All refrigerant suction, chilled water and brine lines”. This wording matches the wording in Table 120.3-A.

Item 2, “**Space Heating Systems.** All Steam, steam condensate and hot water lines”. The wording is slightly different than the wording used in Table 102.3-A. the Table reads; “Space heating, Hot Water systems (steam, steam condensate and hot water)”.

For fluid temperatures above 104F, the table clearly establishes insulation thicknesses based on fluid temperature ranges for “Space heating, Hot Water systems (steam, steam condensate and hot water) and Service Water Heating Systems”. The comma between Space heating and Hot Water systems indicates Space Heating Systems in addition to Hot Water Systems must be insulated per Table 120.3-A.

The following question was presented to:

Energy Standards Hotline Staff
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Does section 120.3(a)2 define Space Heating Systems as only Steam, steam condensate and hot water? If Space Heating were accomplished with a refrigerant gas (refrigerant vapor) would the Space Heating section of Table 120.3-A apply to these pipes?

The Energy Standards Hotline Staff referred the question “up” to the Building Standards Office with responses from two people;

Danny Tam, Mechanical Engineer - Efficiency Division, and
Peter Straight - Supervisor, Building Standards Office.

Following are written responses from those individuals.

“Basically, the intent of the Section and its current language are out of sync. The intent is that hot fluid lines in a space heating system are insulated, and not limited to the current language (steam, condensate, hot water). Based on your comment, we’ve made changes to the proposed 2019 language to include refrigerant under space heating system. We will also work with our outreach office to put out a Blueprint article to clarify this.

Below is the proposed 2019 language in Section 120.3.

(a) **General Requirements.** The piping conditions listed below for space-conditioning and service water-heating systems with fluid temperature listed in TABLE 120.3-A, shall have at least the amount of insulation specified in Subsection (c):

1. **Space Cooling Systems.** All refrigerant suction, chilled water, and brine lines.
2. **Space Heating Systems.** All refrigerant, steam, steam condensate and hot water lines.”

Danny Tam | *MECHANICAL ENGINEER*
CALIFORNIA ENERGY COMMISSION | *EFFICIENCY DIVISION*

“I’ll add that because heat pumps are inherently able to operate in either direction, they are nearly always subject to both the “Space Cooling System” and “Space Heating System” requirements of this Section regardless.”

“...yes, our Hotline staff would advise projects to incorporate this insulation under the current regulations. The intent of the regulations are to ensure that hot and cold fluid lines are insulated... heat pump systems are intended to comply with the insulation requirements specified in this Section for both “space cooling systems” and “space heating systems”.”

Peter Straight
Supervisor, Building Standards Office
California Energy Commission

CONCLUSION

When VRF/VRV systems are operating as a cooling system, Table 120.3-A, the Space cooling systems section of the table would apply as minimum insulation requirements for the low-pressure vapor line (suction) per California Title 24. Check carefully to determine the manufacturers Low-Pressure vapor (suction) operating temperature range. The system designer should also verify the insulation thickness required by the equipment manufacturer, and assure that insulation thickness is sufficient to prevent condensation on the surface of the insulation. The criteria or standard requiring the most insulation thickness should govern.

VRF/VRV systems are also the heating system for the building and per the opinion of the California Energy Commission Energy Standards staff, must comply with the Space heating section of Table 120.3-A. The insulation thickness shown in this section of the table applies to current projects. This will affect both the High-Pressure Vapor and the High-Pressure Liquid line insulation thickness requirement. Equipment manufacturers refrigerant temperature operating ranges should be used to determine the governing row of Table 120.3-A. Most 3-pipe VRF/VRV systems have a high-pressure vapor line operating at temperatures exceeding 201°F,

while two-pipe heat recovery systems may have the 2-phase (liquid/gas) high-pressure line operating at temperatures below 200°F.

Treating a VRF/VRV system as a Space cooling system ONLY is not a correct assumption for the purposes of determining pipe insulation thickness per California Title 24. The table below is a reproduction of Table 120.3-A from the California 2016 Building Energy Efficiency Standards, modified to show pipe sizes as Outside Diameter In lieu of Nominal Pipe Diameter and to replace “Fluid Temperature Range” with “Refrigerant Temperature Range”. A column was added to show “Refrigerant Condition or Phase”.

The following Table is enhanced for application to VRF/VRV Refrigerant Piping Systems											
REFRIGERANT CONDITION or PHASE	REFRIGERANT TEMPERATURE	INSULATION MEAN RATING	ACR TUBING OUTSIDE DIAMETER								
	RANGE (F)	TEMPERATURE (F)	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1-1/8"	1-3/8"	1-5/8"
INSULATION THICKNESS REQUIRED (INCHES)											
HI PRESSURE VAPOR	201-250	150	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
	141-200	125	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	2"
LIQUID	105-140	100	1"	1"	1"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
LOW PRESSURE VAPOR	40-60	75	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"	1"
	BELOW 40	50	1"	1"	1"	1"	1"	1"	1-1/2"	1-1/2"	1-1/2"
PIPE INSULATION THICKNESS for ACR REFRIGERATION PIPING per 2016 CALIFORNIA TITLE 24											

The piping system designer for VRF/VRV systems must be fully aware of the unique insulation requirements for these systems. The proper insulation thickness may be determined by one of many factors, including but not limited to, Code Requirements, Equipment Manufacturers Requirements, Condensation Prevention, and Good Engineering Practice.