VENTING OF CATEGORY IV APPLIANCES (HIGH-EFFICIENCY FURNACES)

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INTRODUCTION

Proper venting of high-efficiency condensing furnaces is extremely important to the proper operation of the equipment and to the safety of the building's occupants. An improperly vented system may reduce the unit's efficiency or prevent the unit from operating. Leaking combustion products—which may include carbon monoxide—can cause severe illness or even death.

It is not the intent of this article to provide a full guide to venting, but rather to highlight the basic procedures that can help the technician prevent costly or possibly even deadly mistakes. All systems must be vented in accordance with the manufacturer's specifications and all local codes. *The technician must read and follow the manufacturer's instructions for the equipment being installed.*

National Fuel Gas Code Table 10.4.1
"Category II, III, and IV gas utilization equipment shall be vented using materials furnished or specified by the gas utilization equipment manufacturer. The venting system shall be installed in accordance with the gas utilization equipment manufacturer's installation instructions."

DEFINITION OF ANSI CATEGORIES OF GAS APPLIANCES

For venting purposes, gas appliances are classified into four categories, defined by ANSI as follows:

Category I

"An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that minimizes condensate production in the vent. May include draft hood and fan-assisted furnaces and boilers, vented with Class B or a lined masonry chimney system. These systems have AFUE ratings of 55 to 80% for older furnaces, boilers, and water heaters, and up to 78 to 82% for newer systems. Venting to be done with Gas Appliance Manufacturer's Association (GAMA) tables, or the manufacturer's instructions."

Category II

"An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent."

Category III

"An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent."

Category IV

"An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent. These appliances are typically 87 to 97% efficient and are vented with plastic, stainless steel, or a material other than Class B or masonry. Vent installation must follow manufacturer's instructions."

Remember that the preceding definitions apply to the appliance and do not necessarily reflect the performance of the connected venting system.

Revisions to the standards now require the manufacturer to specify on the nameplate the category of the particular equipment: i.e., "Category I," "Category II," "Category III," or "Category IV." In addition, Category II, III, and IV equipment must bear a marking that states:

> "This appliance requires a special venting system. Refer to the installation instructions for parts list and method of installation."

DIRECT VENTING

A *direct* venting system is one that draws 100% of the combustion air directly from the outside through a sealed pipe that runs from the outside to the combustion chamber. This type of system prevents the possibility of the burner being starved by exhaust fans, tight construction, or other fuel-burning appliances within the same space.

Direct venting also eliminates contaminants (such as chemicals or lint from a dryer) from the indoor space. This arrangement requires two pipes, but it is the best way to ensure that a sufficient amount of clean combustion air is delivered to the burner.

NON-DIRECT VENTING

A *non-direct* venting system draws combustion air from the space in which it is installed. *It is very important to consider the location and construction of the space carefully to make sure that sufficient combustion air can enter the space.*

If it is possible for the building to be placed in a negative pressure due to the operation of exhaust fans or other combustion equipment, this method should not be used. If the environment contains significant amounts of dust, lint, or chemicals that could be drawn into the combustion air, direct venting should be used.

CHIMNEYS

Generally speaking, an existing chimney cannot be used to vent Category IV appliances. A typical chimney has no provision for dealing with the condensate, which means that it could drip from the chimney into the occupied space. The condensate can be very corrosive, and can quickly destroy the masonry and steel materials typically used in chimneys. In addition, code regulations do not allow the common venting of Category IV appliances along with any Category I appliances that may be using the chimney. An abandoned chimney may be used as a chase in which to run new vent piping, as long as the new vent piping runs the entire length of the chimney.

MATERIALS

It is important that the manufacturer's instructions be followed in determining the proper materials for the venting system of an appliance. One of the most critical considerations in selecting a material is the corrosive nature of the condensate. Most applications use PVC pipe for both combustion air intake and venting. The manufacturer also may use other materials, such as stainless steel, that will hold up to the contact with the condensate.

> **National Fuel Gas Code 10.4.2**
> "Plastic piping used for venting equipment listed for use with such venting materials shall be approved."

Category IV appliances use a fan to force the combustion gases through the vent piping. Because the fan creates a positive pressure within the vent pipe, any unsealed joints will allow flue gases to leak outward. Technicians must make certain that all joints are properly sealed and that there are no leaks. PVC pipe should be glued at all joints. Other materials typically provide a gasketed or welded joint to ensure a tight seal.

Some special fittings may be available to make the installation of the venting system easier or to improve

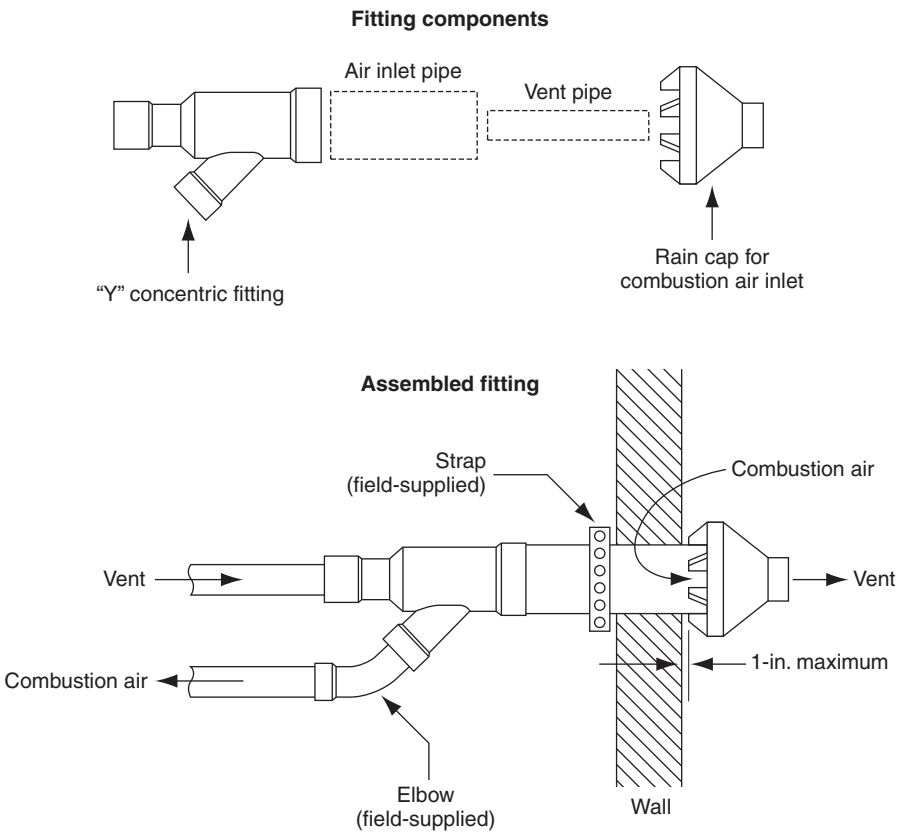


Figure 1. Concentric fitting

its appearance. One such fitting that is often used is a *concentric* fitting (see Figure 1). It allows the vent pipe and the air intake to exit the building through one penetration. The fitting is actually a double-wall pipe with the flue gases in the middle and the air intake around the outside.

PITCH

Pitch is very important to vent piping used with Category IV equipment. Since the normal operation of the equipment causes condensate to form in the piping, some method must be provided to remove that condensate. A typical installation maintains an upward pitch from the equipment to the termination outside the building. As condensate forms in the vent pipe, it drains back to the equipment and out to a proper drain. A low spot in a vent line forms a trap where the condensate collects and prevents flue gases from passing through. Another important reason for pitching the pipe properly is to prevent large amounts of ice from forming on the end of the discharge pipe, which also can restrict the flow of flue gases.

National Fuel Gas Code 10.9
"Provision shall be made to collect and dispose of condensate from venting systems serving Category II and IV gas utilization equipment."

SIZING

Proper sizing of the vent piping is a very important part of the installation. An *undersized* flue pipe creates too much restriction and prevents the proper amount of air from being moved by the induced-draft fan. An *oversized* pipe slows the velocity of the flue gases and causes a greater volume of condensate to form.

All major equipment manufacturers provide sizing tables. Table 1 on page 5 shows an extract from one such manufacturer-specific table. You must determine the total length of pipe and the number of 90° elbows that will be needed before using the table. The hypothetical system shown at the bottom of this page, for example, requires 28 ft of pipe and four elbows. You also know that the furnace in this example has an input rating of 80,000 Btuh. To use the table, match this figure to the equipment rating in the second column. (Note that the first column lists altitude. High-altitude applications require some adjustments.) When you have found the row with the 80,000-Btuh input rating (see shaded box), follow it to the far right-hand columns, which list the number of elbows (1 through 6). In the "4" column (because there are four elbows in our example), you will see the maximum length of pipe that can be used. Find the figure that is closest to and greater than the needed length. Our example calls for 28 ft of pipe, so the next higher number is 30 ft (see shaded box). Now follow that row back to the left to find the proper pipe size (diameter) for the application, which is 2 in. in this case (see shaded box). If the length of the vent piping exceeds that which is listed in the table, you will need to contact the manufacturer.

INSULATION OF THE VENT PIPING

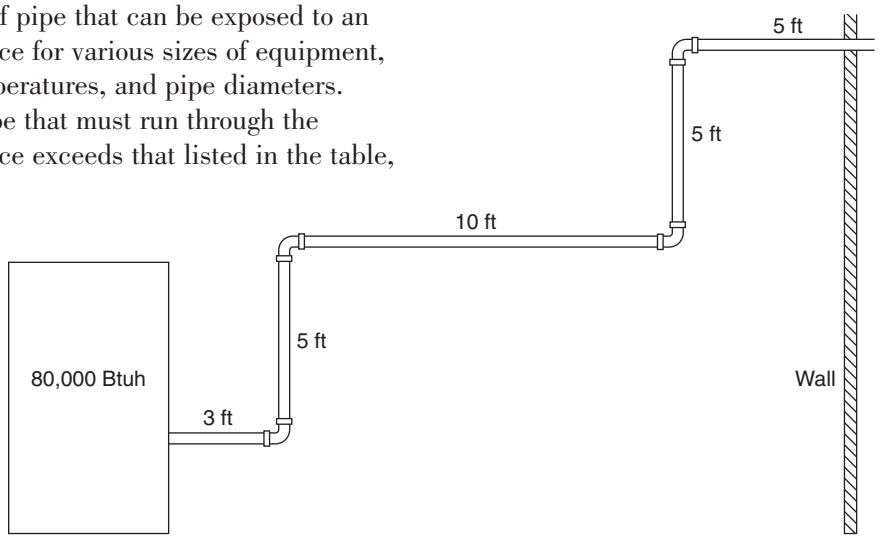
If vent piping is run through an unconditioned space, such as a crawl space or attic, there is a possibility of the condensate freezing inside the vent and restricting the flow of flue gases. Table 2 on page 6 lists the maximum length of pipe that can be exposed to an unconditioned space for various sizes of equipment, winter design temperatures, and pipe diameters. If the length of pipe that must run through the unconditioned space exceeds that listed in the table, insulation should be added to the pipe according to the manufacturer's requirements.

TERMINATION

The proper *termination* of the vent piping is important to consider before starting any venting job. Category IV vents can exit the building either vertically through the roof or horizontally through the sidewall. Terminations must follow the manufacturer's requirements for proper spacing. The termination must be away from any air opening into the building to prevent any of the combustion products from entering the building.

National Fuel Gas Code 10.8.3
"A direct vent appliance with an input of over 50,000 Btuh shall have at least a 12-in. vent termination clearance from any air opening into the building. The bottom of the vent terminal and the air intake shall be located at least 12 in. above grade."

National Fuel Gas Code 10.8.4
"Through-the-wall vents for Category IV appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment."



Terminations also must be located so that condensate that may drip from the end of the pipe will not create a problem. The vent may not terminate over a public walkway. The vent also may not terminate over other equipment, such as a gas meter or gas regulator, where the corrosive nature of the condensate could damage the equipment or the moisture could freeze on the equipment and prevent it from functioning properly (e.g., ice plugging a vent hole on a gas regulator or some type of relief valve).

Altitude (ft)	Unit maximum input rate (Btuh)	Direct vent (2-pipe only)		Non-direct vent (1-pipe) only	Maximum allowable pipe length (ft)					
					Number of 90° elbows					
		Termination type	Pipe diameter (in.)	Pipe diameter (in.)	1	2	3	4	5	6
0–2,000	60,000	2-pipe or 2-in. concentric	1½ 2	1½ 2	20 70	15 70	10 70	5 70	NA 70	NA 70
	80,000	2-pipe or 2-in. concentric	1½ 2 2½	1½ 2 2½	10 55 70	NA 50 70	NA 35 70	NA 30 70	NA 30 70	NA 20 70
	100,000	2-pipe or 3-in. concentric	2 2½	2 2½	5 40	NA 30	NA 20	NA 20	NA 10	NA NA
	120,000	2-pipe or 3-in. concentric	2½ one disk 3* 3* no disk	2½ NA 3*	10 45 70	NA 40 70	NA 35 70	NA 30 70	NA 25 70	NA 20 70
2,001–3,000	60,000	2-pipe or 2-in. concentric	1½ 2	1½ 2	17 70	12 67	7 66	NA 61	NA 61	NA 61
	80,000	2-pipe or 2-in. concentric	2 2½	2 2½	49 70	44 70	30 70	25 70	25 70	15 70
	100,000	2-pipe or 3-in. concentric	2½ 3	2½ 3	35 70	26 70	16 70	16 70	6 66	NA 61
	120,000	2-pipe or 3-in. concentric	3 NA 3* no disk 4* no disk	NA 3* NA 4* no disk	14 63 70 70	9 62 70 70	NA 62 63 70	NA 61 56 70	NA 61 50 70	NA 61 43 70
3,001–4,000	60,000	2-pipe or 2-in. concentric	1½ 2	1½ 2	16 68	11 63	6 62	NA 57	NA 57	NA 56
	80,000	2-pipe or 2-in. concentric	2 2½	2 2½	46 70	41 70	28 70	23 70	22 70	13 70
	100,000	2-pipe or 3-in. concentric	2½ 3	2½ 3	33 70	24 70	15 70	14 66	5 61	NA 56
	120,000	2-pipe or 3-in. concentric	3* no disk NA	NA 3*	65 59	58 59	51 58	44 57	38 57	31 56
		4* no disk	4* no disk	4* no disk	70	70	70	70	70	70

*See explanatory notes at end of manufacturer's table.

Table 1. Combustion air and vent piping for direct vent (2-pipe) and non-direct vent (1-pipe) applications (extract from Carrier 58MTB)

Unit maximum input rate (Btuh)	Winter design temperature* (°F)	Maximum pipe diameter (in.)	Without insulation	With ⅜-in. or thicker insulation*
60,000	20	2	44	70
	0	2	21	70
	–20	2	20	57
80,000	20	2	55	55
	0	2	30	55
	–20	2	16	55
	20	2½	58	70
	0	2½	29	70
	–20	2½	14	67
100,000	20	2½	40	40
	0	2½	38	40
	–20	2½	21	40
	20	3	63	70
	0	3	30	70
	–20	3	12	70
120,000	20	3	70	70
	0	3	38	70
	–20	3	19	70
	20	4	65	70
	0	4	26	70
	–20	4	5	65

*See explanatory notes at end of manufacturer's table.

CARRIER CORPORATION

Table 2. Maximum allowable exposed vent pipe length (ft) with and without insulation in unconditioned spaces (extract from Carrier 58MTB)

Snow must be taken into consideration when placing the vent piping. All piping should terminate at least 12 in. above the expected snow level to prevent blockage due to snowfall (see Figure 2). Clearance to other vent terminations also must be observed.

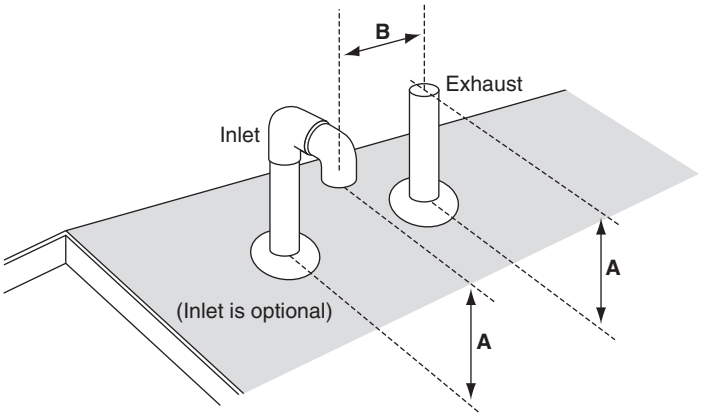
Not all manufacturers have the same requirements, so it is important to check the instructions for the specific equipment.

Direct vent applications may use concentric terminations. This type of termination uses a double-wall pipe, with flue gases carried in the inner pipe and combustion air carried in the outer pipe. The use of the concentric termination allows both pipes to exit through one hole and provides a neat, clean termination.

CONDENSATE DRAINS

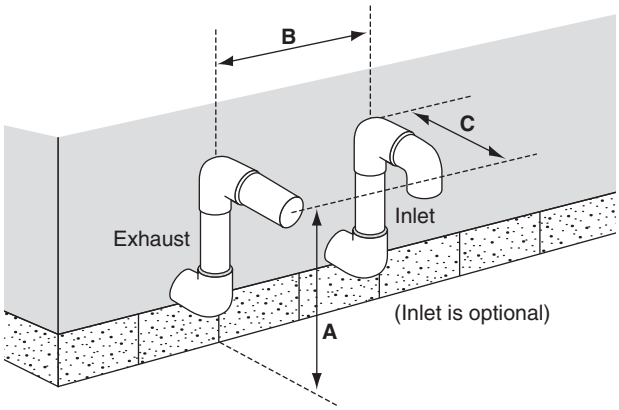
Since Category IV equipment is designed to permit the water in the flue gases to condense, a drain must be provided to remove the condensate. The manufacturer of the equipment normally provides a trap to collect the condensate, as well as a seal between the venting system and the drain piping. Check the manufacturer's requirements for priming the condensate trap.

Piping from the trap is generally PVC because it must be able to handle the corrosive condensate without sustaining damage. The drain pipe should not be piped solidly into the sewer—doing so will allow the effluent from the sewer to enter the equipment in the event of a backup. The drain



Rooftop termination

A = 12 in. above roof or snow accumulation level
B = 8-in. minimum, 20-in. maximum, except in areas with extreme cold temperatures (sustained below 0°F), then 18-in. minimum



Sidewall termination

A = Minimum 12 in. above expected snow accumulation level
B = 8-in. minimum, 20-in. maximum, except in areas with extreme cold temperatures (sustained below 0°F), then 18-in. minimum
C = 8-in. minimum

Figure 2. Termination of vent piping

pipe should terminate at an open-site drain, such as a floor drain.

CODES

The United States and Canada follow very similar codes, which basically state that all venting must meet the manufacturer's requirements. It is important to check codes for your specific area and follow any required variations.

This document provides basic venting guidelines only. There is no substitute for reading the instructions and following all the listed requirements.

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