Fundamentals of Venting and Ventilation

- *Vent System Operation*
- *Sizing, Design and Applications*
- *Installation and Assembly*
- *Troubleshooting*

Pub. No. 34-4010-02

Contents

Venting and Ventilation

When man first began to burn fuel for warmth, he soon learned that the smoke, created during combustion, caused problems when it was allowed to collect at the source. His early caves were selected and later lodges were constructed with an escape for these unpleasant fumes. As he began to employ natural gas as a fuel, he continued to use what he had learned. Today, we still find that proper vent system operation is vital to safe and efficient furnace operation. In this manual, we will discover the things which are needed to provide this vent system.

We will also learn that a gas furnace requires a substantial amount of fresh air to operate properly. This is called ventilation air. This air is used in combustion and as a replacement for the air that a modern home loses through outward flow due to mechanical ventilation. Although we cannot control the loss of air, we can properly diagnose it if it becomes a problem and suggest cures.

The following topics are covered in this manual:

- How a natural draft (gravity) vent works.
- Fan assisted vent systems.
- Power venting.
- Sizing and designing vent systems.
- Supplying adequate amounts of fresh air for ventilation.
- Vent system installation.
- Troubleshooting.

Using the guidelines in this book can help to ensure safe and reliable vent performance for both natural draft and fan assisted furnaces.

Note: No two installations are alike! Take the time to study each application. Plan ahead, use good judgment, and always comply with national, state, and local codes.

Never sacrifice safety for efficiency or ease of installation!

Motive Force in Vents

What causes a natural draft vent to operate? Heat! As we all know, heat rises. This is because heated molecules have a tendency to become agitated and to move about. Because of all this motion, the molecules "bump" into each other creating more space in between them. See Figure 1. This makes the substance less dense - lighter. Referring to Figure 1: As heat is applied to the air inside the balloon it expands and becomes lighter. When enough heat is applied, the balloon will become lighter than the air around it and begin to rise. For this reason, gas furnaces are designed with the heat exchanger outlet located above the inlet. This allows the heated products of combustion to travel in a natural, upward path forming a **natural draft!**

To come back down, the balloonist in Figure 1 merely has to stop applying heat. Soon, the air in the balloon will begin to cool and become heavier. The balloon will then start dropping back to earth.

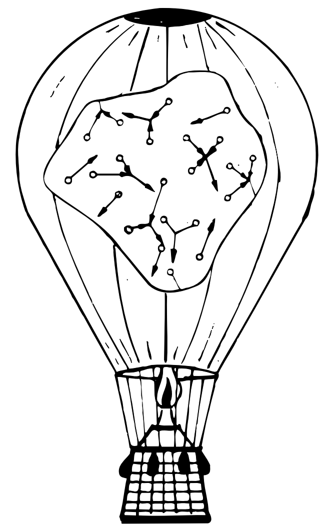


Figure 1

Heat drives the flue gasses out of the furnace because heat always moves from warmer areas to cooler areas. The hot flue-gases would much rather travel up the relatively cool flue pipe than to "back-track" to the much hotter main burner flame.

The final force, which results from the heat which is created, is the pressure difference found between the inside of the vent and the atmosphere around it. The combustion air entering the furnace is at atmospheric pressure which, at sea level, is about 14.7 PSIA (Pounds to the Square Inch Absolute pressure). The hot flue-gases rising out of the furnace are less dense, creating a pressure drop within the heat exchanger. This "gap" is continually being filled by the higher pressure entering air/gas mixture. So, in effect, the gasses entering the furnace are helping to "push" the flue gasses out of the furnace. See Figure 2.

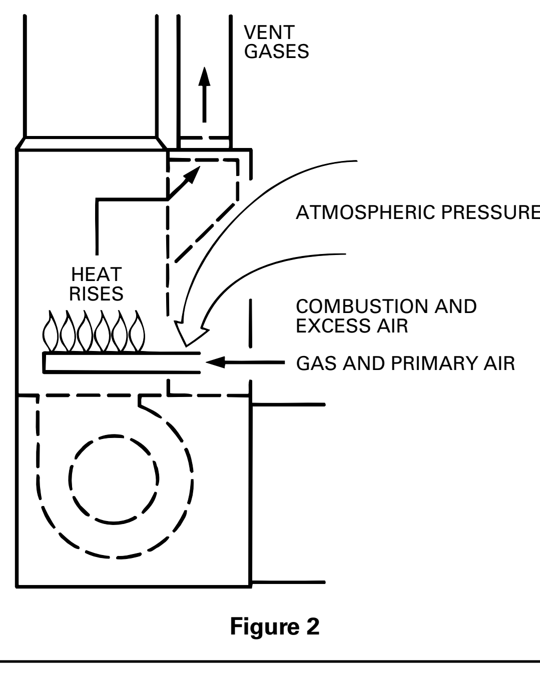


Figure 2

Factors Affecting Vent System Design and Operation

There are many variables dictating how well a vent system will operate. They are: **1.** flue-gas temperature **2.** heat loss in the vent **3.** vent height **4.** vent system capacity **5.** restrictions to flow and **6.** the ambient temperature.

Flue-Gas Temperature

Flue-gas temperature affects vent operation because the hotter the gases are, the lighter they are. The design BTUH (British Thermal Units per Hour) capacity of the vent plus the furnace input and efficiency are factors affecting the temperature of the flue-gases. Higher BTUH furnaces produce higher flue-gas temperatures. On the other hand, the higher the efficiency of a furnace, the lower the flue-gas temperature. Two cases which can cause poor venting are the oversizing of the vent or reducing the BTUH input to an existing vent system. Either case will result in excessive cooling of the flue gases and a reduction of the vent forces.

Heat Loss

The amount of heat lost through the vent is based on two factors. They are: the ability of the vent pipe to transfer heat, and the temperature difference between flue-gases and the air around the vent. Single wall metal vents conduct heat well. Some non-metallic vent materials may absorb large amounts of heat. Double wall metal vents are often preferred because of their insulating qualities and the fact that the relatively thin inner walls do not absorb much heat.

Temperature differential affects heat loss because of heat flow-rate. The greater the temperature difference is on either side of a substance, the faster the heat will flow through the substance. For example, sections of vent pipe passing through an unconditioned space will lose heat more rapidly than vents within a conditioned space.

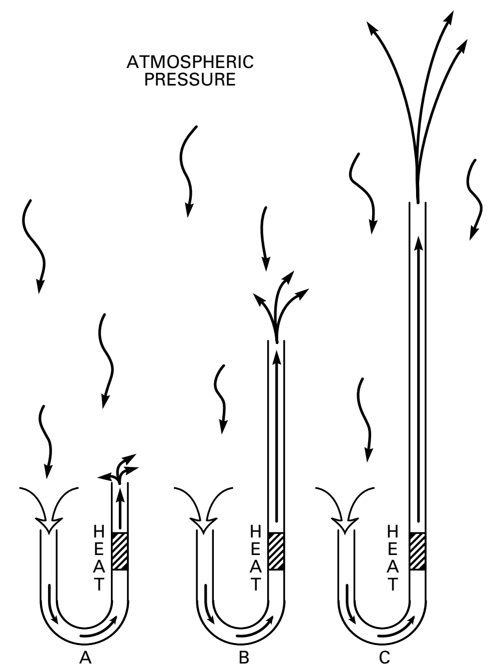


Figure 3

Vent Height

Where vent height is concerned, taller is better. As an illustration of this principle, refer to Figure 3. In 3A, the air leaving the heat source has only a short distance to travel before encountering atmospheric pressure. This retards the ability of the flue-gases to set up a good flow before encountering resistance. Figure 3B shows a taller vent pipe which allows the flue-gases to gather a little more momentum before exiting the vent pipe. Therefore, they have a better chance of overcoming the atmospheric pressure at the vent outlet. Sample 3C is even better still. Because of resistance in the pipe, gravity, and the cooling of the flue-gases, you can make the pipe too long. There will be a point where these factors counter-balance the momentum of the flue-gases. This limit is not usually reached.

Vent System Capacity

The volume of flue-gases produced by a furnace directly depends on the BTUH input of the furnace. The greater the BTUH input of the furnace, the greater is the amount of combustion products which need to be removed. Vent system design tables take into account, among other things, the volume of gases which will be produced by a furnace of a certain input.

If the input is greater than the capacity of the vent,then the vent will be unable to carry all of the flue products away.

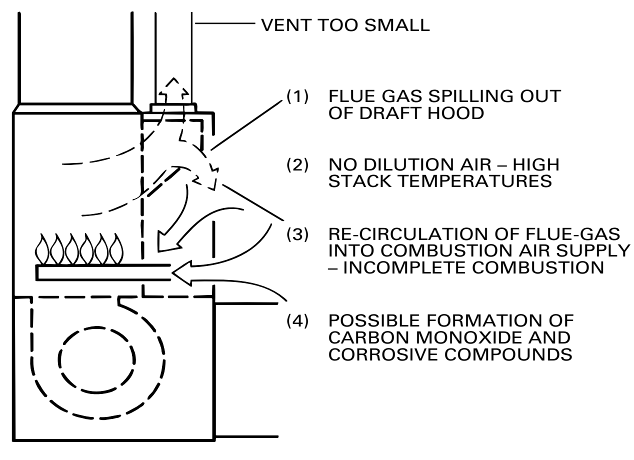


Figure 4

As a result, flue products will spill out of the draft hood relief opening. Figure 4 illustrates some of the problems which may result from undersized vents.

We have traditionally relied on the adage " Bigger is better!" However, if the BTUH input is substantially below the capacity of the vent, the flue-gases will cool off before reaching the end of the vent. The fan-assisted furnaces are affected by this and the charts which apply to them have been re-written to reflect this concern. The reduction in the drafting forces can lead to condensation and acid formation within the vent. Acids and condensation are the greatest enemies of the gas appliance vent.

Resistance to Flow

Resistance in a vent pipe can come in several forms. Some examples are vent fittings such as elbows, tees, vent caps, and end screens. Other, more subtle, examples are wall roughness of the vent pipe, the shape of the vent pipe (round, oval, square, rectangular) and the configuration of the vent system. Resistance caused by fittings is unavoidable. The vent designer can only limit the number of fittings to the minimum necessary. Resistance pertaining to vent system configuration can be held to a minimum using good, common-sense design procedures.

Fittings such as elbows and tees cause the flue gases to change direction and result in a loss of momentum. Other fittings such as end screens and flue baffles take up space in the vent. This effectively reduces the area of the vent pipe and, therefore, reduces the capacity of the vent.

The shape of the vent does affect operation somewhat, but it is not as critical as the other factors mentioned. Gas flow through a round pipe is less turbulent than through a square or rectangular pipe. However, because we are talking about relatively low velocities, the effects of turbulence are minimal and are usually not considered.

Of significant importance is the configuration and installation of the vent system. Most charts allow two 90° bends in the vent as they are written. Added 90° bends in the vent system cause a 10% loss in vent capacity. An excessive number of bends in a vent can overcome the drafting action completely. Later, in the section on vent system design, the effects of friction losses from bends is covered in more detail. Also, since flue-gases want to rise, horizontal (lateral) sections do not contribute to draft action. For this reason, **lateral runs of vent pipe must have an upward pitch of one-quarter (1/4) inch of rise per every foot of run.** This is not a great deal of slope, but it is necessary to help ensure the upward travel of the flue-gases. In the extreme, a lateral run with a slightly downward slope can actually act as a “trap” and prohibit the flow of flue products.

Two good rules to follow when designing and installing vent systems are: **(1) avoid an excessive number of turns and bends (Figure 5) and (2) maximize rise; minimize run.**

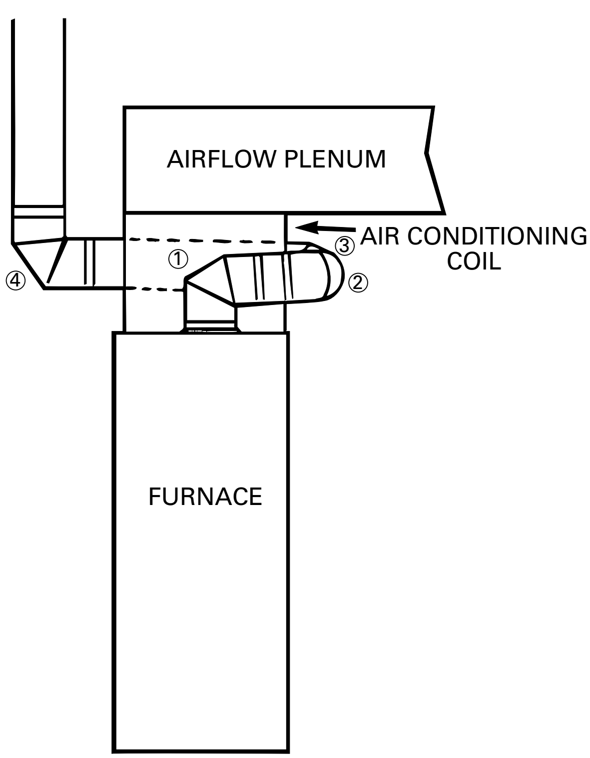


Figure 5

Ambient Temperature

Two ambients must be considered. First, consider the ambient temperature of the air around the vent pipe. As stated earlier, heat loss through the vent pipe walls can take away from the draft force. Heat flow rate through a substance is directly related to the temperature difference on either side of the substance. The greater the temperature difference, the greater the heat flow rate. Care must be taken when running vent pipes through unconditioned spaces such as a ventilated attic. It is a good idea to insulate vent pipe in unconditioned spaces.

On the other hand, when it comes to combustion air supply, a lower entering air temperature is better. The cooler a substance is, the more dense it is. Being more dense also means it is heavier. Cooler air gives us more “push” at the combustion air inlet. In the case of a unit which draws all of its combustion air from outside, the vent system will perform better on colder days when the difference in temperature is greatest.

Satisfactory Operation

Section 7.2.1 of the **National Fuel Gas Code** (NFPA54/ ANSIZ223.1), under minimum safe performance, states that a venting system shall be designed and constructed so as to develop a positive flow adequate to remove all flue or vent gases to the outside atmosphere.

Ventilation Requirements

Any discussion of venting must include coverage of ventilation. Ventilation is the process of replacing the air which is required for the furnace operation. The amount of ventilation air supplied within the structure must equal all of the air requirements of all of the gas-fired equipment in the building **plus** any air quantities removed by range hoods, exhaust fans, etc. Whole house ventilation fans, sometimes called attic fans, are not considered because they are not usually in operation during the heating season.

A natural draft furnace’s combustion air supply is divided into four parts. **Primary air** is pre-mixed with the gas inside the burner and makes up only about 20% of the air required to completely support combustion. **Secondary air** completes combustion by entering the furnace through openings near the burners and mixing with the gas at the burner flame.

In order to ensure adequate air supply to the burner, most furnace designs have air openings sized to provide the burner with more than enough air for combustion. This extra air is called **excess air** and the furnace design will determine the amount of excess air which will be used.

This excess air supply ranges, by design, from 30% to 50% of the requirements for complete combustion. **Dilution air** is that air which is drawn in through the draft hood or draft diverter relief opening. Dilution air is a "side-effect" of the need to have a relief opening. The main purpose of the relief opening is to relieve negative pressure extremes in the vent which may cause pilot flame outages or "lifting " of the main burner flame. Fan assisted furnaces do not use dilution air.

Sometimes, dilution air is necessary to lower flue-gas temperatures to a less hazardous level. Figure 6 shows the hot flue gases exiting the heat exchanger in an upward motion. This motion creates a pressure drop in the area of the relief opening. Because of this pressure drop, the air around the draft hood/diverter is drawn into the flue. This is because the ambient air is at atmospheric pressure and will flow to any area under less pressure.

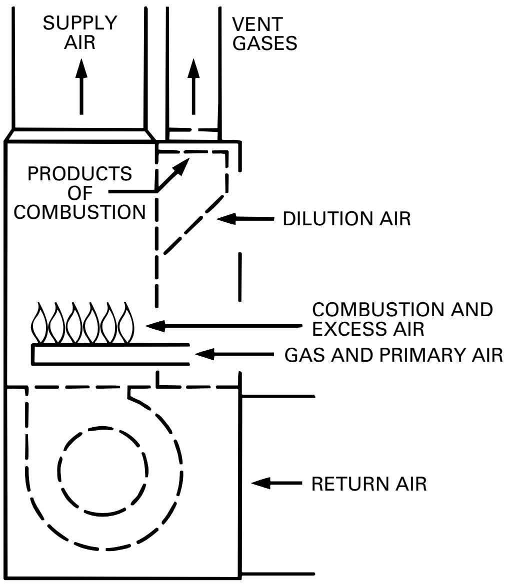


Figure 6

Just how much dilution and excess air is required? Consider a couple of facts. First of all, we realize that the air around the draft hood is at the same atmospheric pressure as the air going into the combustion air openings. Second, the draft force at the draft hood/diverter is equal to and possibly greater than the draft force at the combustion air openings. These facts can lead us to conclude that the dilution air supply is equal to or greater than the combustion and excess air supplies combined.

To determine the total ventilation air requirement:

Example: Input = 100,000 BTUH, 50% excess air

1. Obtain the minimum air required for complete combustion. NOTE: Approx. 10 cu. ft. per 1000 BTU

   Calc: BTUH input ÷ 1000 BTUH x 10 cu. ft. = cfh (cubic feet per hour)

   Ex: 100,000 ÷ 1000 x 10 = 1000

2. Multiply the result by the excess air percentage

   Calc: Minimum requirement x excess air % = excess air

   Ex: 1000 x .5 = 500

3. Add the excess air to the minimum requirement

   Calc: Min. req. + excess = primary & secondary air

   Ex: 1000 + 500 = 1500

4. Double this result to account for dilution air

   Calc: Primary & secondary air x 2 = total

   Ex: 1500 x 2 = 3000 cfh or 50 cfm (cubic feet per minute)

Vent Sizing and Design

As mentioned previously, in order for a natural draft or gravity vent to work properly, it must have heat. **The proper amount of heat will be available only if the vent is sized properly.** Too small a vent will not have the capacity to carry all the combustion products outdoors. Too large a vent will allow excessive dilution air to mix with the combustion products and cool them so that a proper draft is not created. The vent must be made of a material that heats up quickly so that the draft will be established before combustion products spill into the room. Large, unlined masonry chimneys take so much heat to warm them that the venting may not take place properly for some time. Single-wall vents lose heat so fast that a proper heat level may not be established. In new construction, double-wall vents offer a good choice as a chimney liner for gas-fired appliances, if a lined chimney is to be provided. Before going on to detailed sizing instructions, a brief discussion of the types of products to be vented is in order.

Furnace Categories

In 1981 a task force from the American National Standards Committee was formed to develop recommendations for venting high efficiency gas appliances. One of the results of their work is the classification of gas appliances in relation to their venting characteristics. The two properties which are used for classification are the static pressure within the vent system and the temperature of the flue-gas entering the vent.

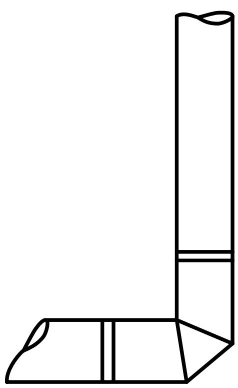
By static pressure in the vent, gas appliances are classified as positive or non-positive. A non-positive appliance vent will operate under zero or negative static pressures. Leakage in the vent system will flow into the pipe. A positive appliance will produce a positive static pressure within the vent. Because of this, measures to seal the vent against leakage must be taken when venting appliances classified as positive.

Where flue-gas temperature is concerned, the separation of categories is determined by whether or not condensation may occur inside the vent. A limit of 140°F (140 degrees fahrenheit) above the flue-gas dew-point was the value derived through testing and simulation. Appliances producing flue products with a temperature less than about 275°F (see Table 10 in the Appendix) have a high probability of condensation forming in their vents. Vent systems for these appliances, found in Categories II and IV, must be constructed of a corrosion resistant material. Table 10 lists the different categories, the temperature and pressure attributes of each, and their venting requirements.

Design Considerations for Venting the Separate Furnace Categories.

Category I

Furnaces classified as Category I are non-positive with entering flue-gas temperatures greater than or equal to 140°F above their dew-point. This category includes all natural draft appliances and most induced draft or "fan assisted" appliances. Table 10 lists the venting requirements as being specified in Tables 1 through 6 or the **National Fuel Gas Code** (Figure 7). **A word of caution:** this category covers a wide range of products. Included in this category are the medium-high efficiency furnace models with efficiencies ranging from around 78% to just below 83% AFUE(Annual Fuel Utilization Efficiency). These primarily "fan assisted" furnaces produce flue products which are equal to or just above the 140°F above dew-point limit mentioned earlier. The title "fan assisted" refers to the gas combustion portion of the furnace, not the indoor blower for structure indoor air.



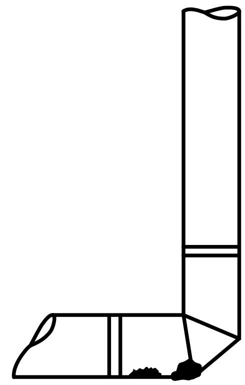
CATEGORY I
NO SPECIAL CONSIDERATIONS

Figure 7

The vent sizing tables mentioned were originally designed on the assumption that entering flue-gas temperatures are above 360°F and have dilution air drawn into the vent system through the draft diverter. With furnace models in the efficiency range around 80% AFUE, flue-gas temperatures can be lower. With induced draft appliances, there is no dilution air. Accurate sizing of the vent systems for these models is critical. Later, in the section on sizing and design, proper venting of any Category I appliance or combination of these appliances will be covered using the latest release of these tables.

Category II

Category II furnaces are those non-positive furnaces which produce flue products less than or equal to 140°F above their dew-point. Because of the lower flue-gas temperature, the venting material must be resistant to corrosion. See Figure 8. This is because there is a good chance that condensation will occur in the vent. It is also necessary that the vent material have a low heat transfer coefficient. There are currently some thermoplastic materials being used with these types of furnaces and gas appliances.

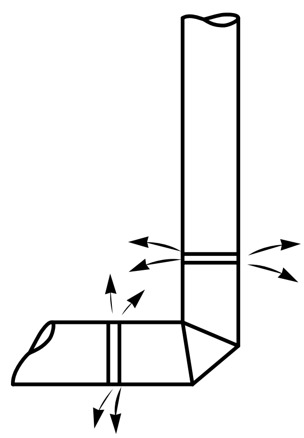


CATEGORY II
CORROSION RESISTANT

Figure 8

Category III

Category III furnaces are forced-draft furnaces with flue-gas temperatures greater than or equal to 140°F above dew-point. Because of the high flue-gas temperatures, condensation is not expected to occur in the vent systems for these products. Therefore, corrosion resistant vent materials are not specifically required. A special case is created when an induced draft furnace is to be vented horizontally. This will be covered later.



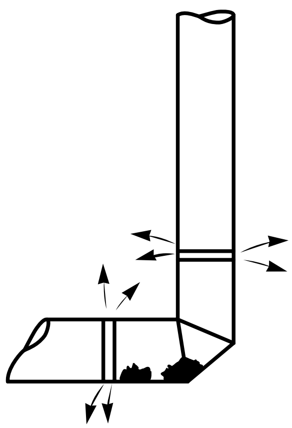
CATEGORY III
LEAK TIGHT

Figure 9

The vent systems for these forced-draft products are under positive pressure and must be leak-tight. Any leaks in these vent systems will be outward and will contaminate the atmosphere around the vent. See Figure 9.

Category IV

Category IV furnaces are the 90+ AFUE high efficiency models. These forced-draft furnaces have flue-gas temperatures less than or equal to 140 degrees F above their dew-point. The vent systems must be corrosion resistant, see Figure 10, as the lower flue-gas temperatures will lead to condensation in the vent. Also, since they operate under positive static pressures, the vents must be designed and installed to be leak-proof. PVC and CPVC plastic pipes may be used with the 90+% furnaces, when recommended by the manufacturer.



CATEGORY IV
LEAK TIGHT &
CORROSION RESISTANT

Figure 10

Types of Vents

Vent Classifications

Vents are classified by their construction, durability and resistance to heat and corrosion. The categories include: Chimneys, Type B vents, Type B-W vents, Type L vents, single-wall metal pipe, and plastic pipe.

A **chimney** is a vent constructed of masonry, reinforced concrete or metal. Masonry chimneys are the most common and were originally developed for use with coal or oil fired systems.

Special considerations are involved when using a chimney for venting a gas appliance. Chimneys used to vent Category I central furnaces must be either tile-lined or lined with a listed metal lining system. If a fan assisted furnace is to be used, the chimney must be internal to the structure and have another appliance, with natural draft, common venting into it or be lined with a Type B vent or a listed flexible metal lining system sized in accordance with the appropriate tables and notes. If one or more walls of the chimney are exposed to the outside of the structure, the chimney must be lined with a Type B vent or a listed flexible metal lining system. Masonry chimneys, which have been converted for gas after being used to vent coal, oil, or wood burning equipment must be lined with a suitable metal liner. **Unlined masonry chimneys are prohibited.**

Special attention must be given to the chimney's construction and location. Flue construction is especially important. The flue height and area affect the ability of the chimney to provide a good draft. Also, cracks and leaks in flue walls are a fire hazard.

Location of the chimney also affects venting. Chimneys located outside of the structure require a long warm-up period to establish adequate draft. See Figure 11. Chimneys on outside walls are more prone to condensation and therefore early deterioration.

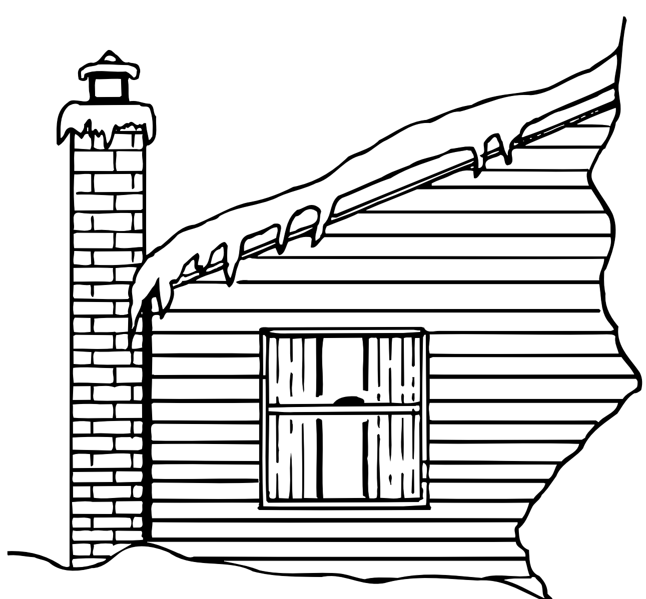


Figure 11

Type B vents are widely used in new construction because of relatively low cost coupled with good performance. These vents can be made of aluminum, steel, or clay tile. Metal Type B vents employ double wall construction with an insulating air space. See Figure 12. When installed with specified clearances, excessive temperatures on surrounding combustible materials can be avoided.

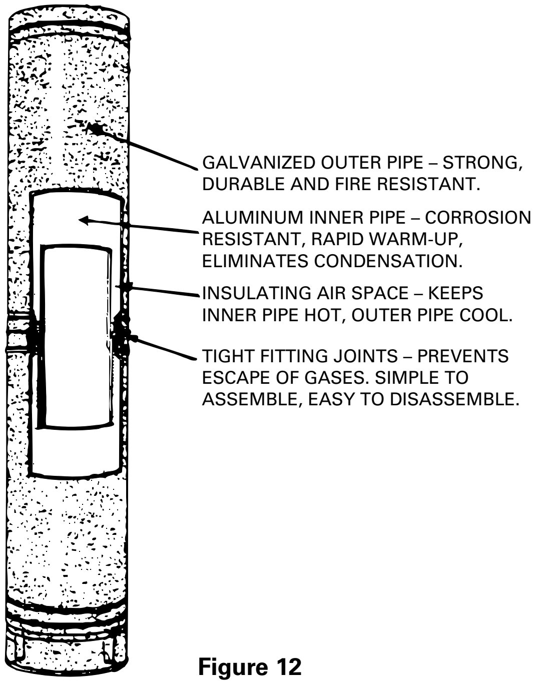


Figure 12

Type B-W vents are very similar to Type B vents except they are an oval shape. They are of double-wall metal construction and are designed specifically for venting recessed wall heaters. See Figure 13. Type B-W vent pipe is also often used when it is desirable to "hide" Type B vents in the wall.

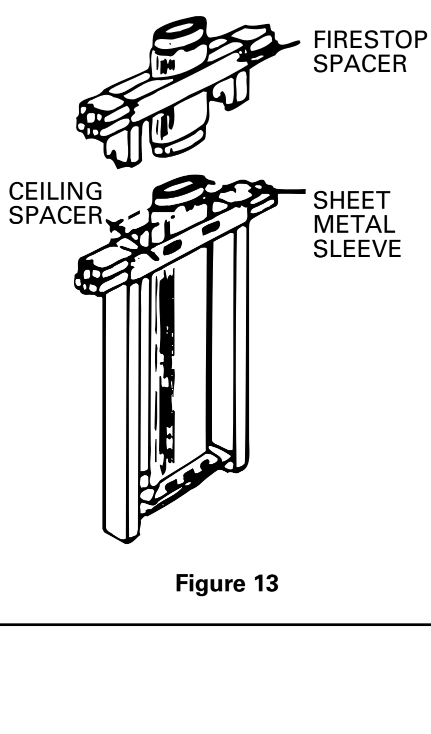


Figure 13

Type L vents are also similar to Type B except they are higher in resistance to heat, fire, and corrosion. Type L vents have durability and resistance characteristics equivalent to fire-clay tile, cast iron or stainless steel. Other parts of the vent system which may be subject to condensation or contact with flue gases are constructed of the same materials and may include aluminum coated steel.

Type L vents are for use with oil and gas appliances listed as suitable for use with this type of vent. They can also be used as a substitute for a type B vent or used for chimney or vent connectors. The use of type L vents is not common, although they are frequently selected for applications where heat and/or corrosion may be a problem.

Single-wall metal vents have limited applications. In some areas, local codes prohibit the use of this type of vent. Where permitted, vent material should be of at least 20 ga. galvanized sheet steel or at least 24 B & S gauge sheet copper or other non-combustible, corrosion resistant material.

The applications of single-wall metal vents are limited to runs from the appliance location directly through the roof or exterior wall. If, however, the vent is to extend back and upward through the eaves, the use of single-wall vents is not recommended. If a single-wall vent connector is adjacent to a cold outside wall, then it should be insulated. Another way to prevent the connector from losing too much heat to the wall would be to space it away from the wall. See Figure 14. Single-wall vents are not to be used for runs which pass through any concealed portions of a structure.

Flexible metal lining systems may be used in lining masonry chimneys. These liners are sized using the tables for Type B vents with the maximum rating reduced to 80% of the table rating. (Table maximum times 0.80 equals flex maximum.) The minimum rating is not affected.

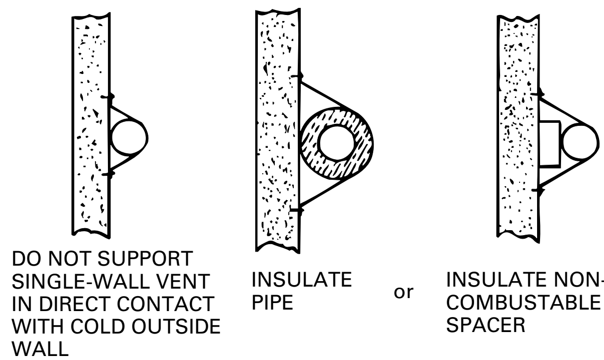


Figure 14

Plastic Pipe

Due to the advent of higher efficiency furnaces, and therefore lower flue-gas temperatures, many manufacturers are specifying plastic vent pipes for their products. Plastic pipe has the advantages of corrosion resistance and leak-tight assembly. Two basic formulations are used: On 90+ AFUE furnaces, PVC and CPVC. For the 78 to 83% AFUE furnaces, a UL listed high temperature plastic pipe may be used. See the manufacturers' installation instructions for details.

Vent Materials

A wide variety of materials are being used for vents today. Each of these materials has its own advantages and disadvantages.

Galvanized steel is low cost and fairly easily formed. Type B vents using galvanized steel have a good insulating quality and warm up quickly. This quick warm-up and insulating ability helps to establish a good draft early in the heating cycle. The disadvantage of galvanized steel is that it is not as corrosion resistant as some other materials.

The main advantage in stainless steel is its resistance to corrosion. The disadvantage is the higher cost.

Masonry, clay-tile, and concrete vents have a disadvantage of a prolonged warm-up period. Also, the mortar used in such vents is very susceptible to deterioration when condensation occurs in the vent. One advantage of these types of vents is they retain heat longer.

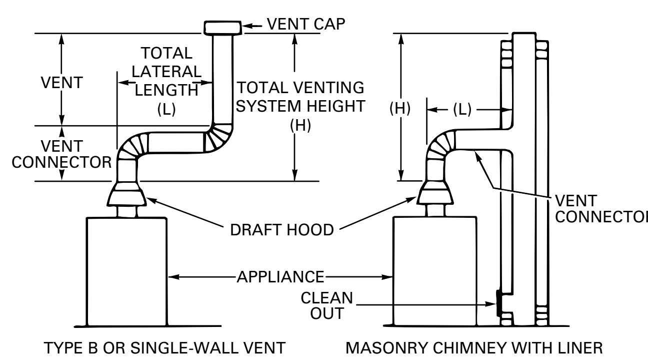
PVC vents have a high corrosion resistance and can be assembled with leak proof joints. However, this material is good only for applications where the flue-gas temperature does not exceed 180°F. CPVC has a higher flue-gas temperature rating than PVC but is also limited to those applications of 90+ AFUE high efficiency furnaces. Follow manufacturers' instructions on application.

Vent Design Configurations

Each individual venting application has its own special considerations. The building structure, the orientation of the building, and the input of the gas appliances which the vent serves are just a few of the things which the vent system designer must consider. There are four basic categories of vent systems. The first category is the single appliance natural draft vent system. Then, there are two categories which cover the common venting of multiple appliances. One of these configurations is called manifold venting and involves multiple appliances on the same floor of a structure. The other method of common venting involves the use of individual connectors of each appliance sharing the vent and can be a single story or multi-story installation. The last category is special, covering power venting and direct venting.

Single Appliance Natural Draft Vent System

A natural draft or gravity type vent system relies only on the lifting force of the hot gases in the vent and does not rely on a blower or exhaust fan to assist the flow. An important fact to keep in mind is that the fan used in a fan assisted furnace, found in Category I and II, does not create a positive pressure. It only overcomes the natural resistance of the heat exchanger to the passage of flue gasses. These furnaces are still classified as Fan Assisted, Category I, in their application. Typical single appliance venting systems are shown in Figure 15. The **vent** is the portion of the system where the gases normally begin their final ascent. The piping assembly that conveys the combustion gases to the vent is called the **vent connector**. It may have both vertical and horizontal sections where the vent is normally vertical only. Together the vent and vent connector make up the venting system.

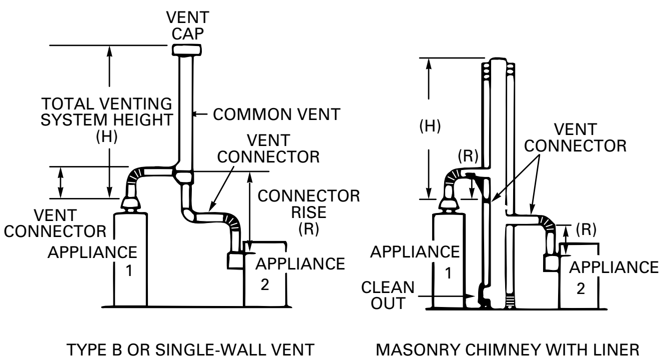


Single appliance natural draft vents

Figure 15

Multiple Appliance Venting

Often, it is desirable to use the same vent to vent more than one appliance. This is known as **common venting.** When venting multiple appliances, the operation of the unit with the smallest input is the most critical. When only this one appliance is operating, dilution air will also be drawn in through the draft hoods of the inactive natural draft appliances sharing the vent. This causes excess dilution, which leads to lower flue gas temperatures, which causes a reduction in draft. Figure 16 shows two examples of venting two appliances on the same floor of the building.



Multiple appliance natural draft vent (common venting – same floor)

Figure 16

When using a common vent, the vent connector design is the key element. It is a good idea to treat each connector for each appliance as a vent in itself. Vent connector rise is critical. See Figure 17. Where overhead clearance inhibits adequate connector rise, it may be necessary to run the connector through the ceiling and then connect it to the common vent. See Figure 18.

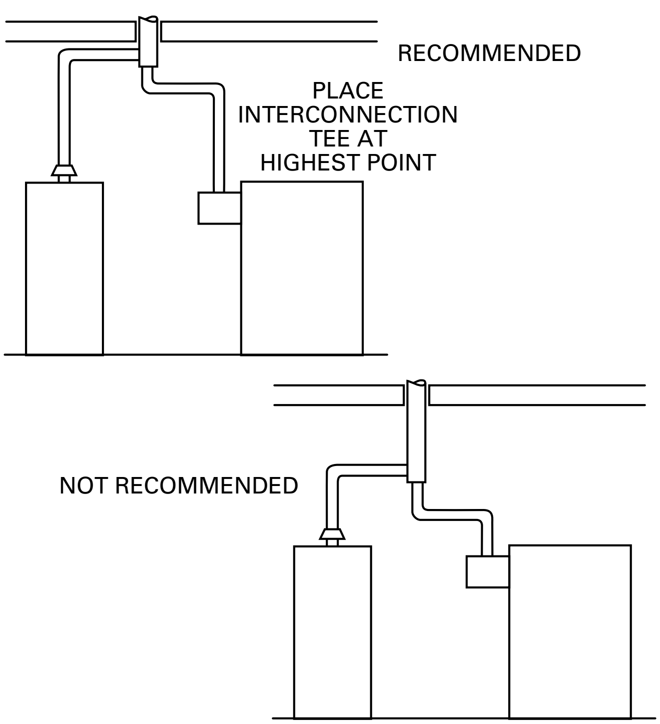


Figure 17

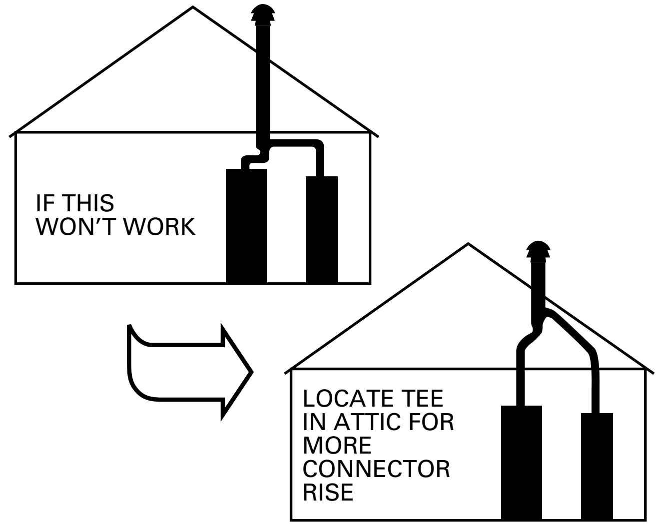


Figure 18

Also, when venting two appliances, the vent connector from the appliance with the smallest heat input should enter the common vent at the higher point of the interconnecting tee. Vent connectors from separate appliances should never enter the common vent on the same horizontal plane. See Figure 19. In other words, don't use the "Cross" of the "Tee" to connect appliances to the vent.

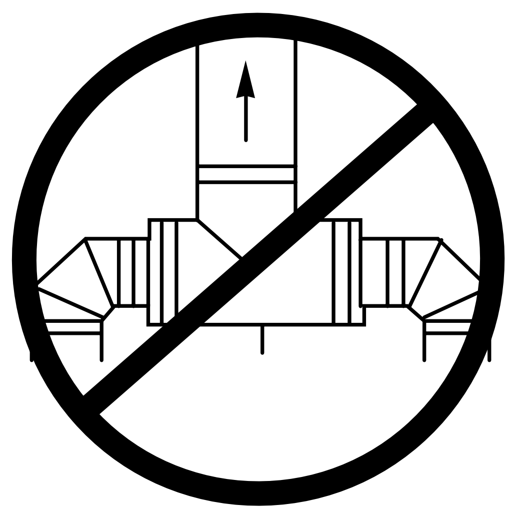


Figure 19

The inter-connecting tee should never be smaller than the size of the largest connector, see Figure 20, and should be as large as the common vent.

If the basic guidelines outlined in this section are followed, then common venting can be a safe, cost effective way

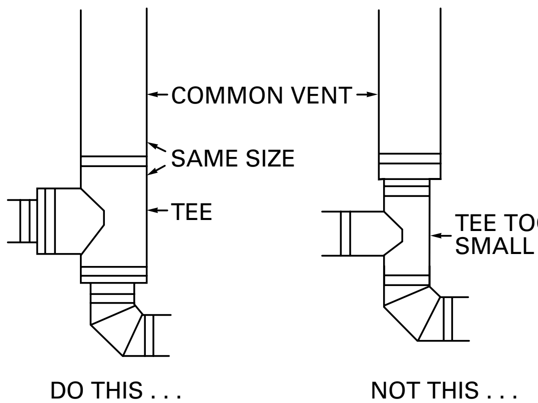


Figure 20

to vent more than one appliance. If particular attention is paid to connector rise, the connector may actually be self-venting, and the common vent may not be required to produce any draft.

Keep in mind, individual vents sized for a specific appliance will have more reliable performance. Also, common venting, with all of the necessary fittings, may actually be the more expensive route. Consider these things before deciding whether to vent separately vertical, horizontal or in a common vent.

Manifold Venting

In venting a group of appliances on one level, a manifold vent can be used. A manifold vent is a horizontal extension of the lower end of the common vent. The manifold portion will be attached to the vertical vent with an elbow or tee. As shown in Figure 21, the manifold may be graduated or of constant size. Different design procedures are used for each type. There are no hard and fast rules of design.

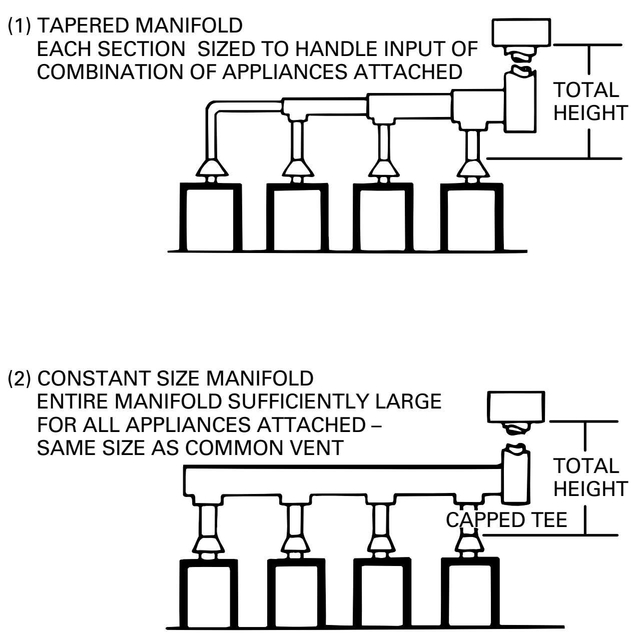


Figure 21

Type B vent manufacturers do supply tables with their recommendations. In general, adequate connector rise is essential to prevent spillage. Manifold length should be limited to 10 feet or 50 percent of the total vent height, whichever is greater.

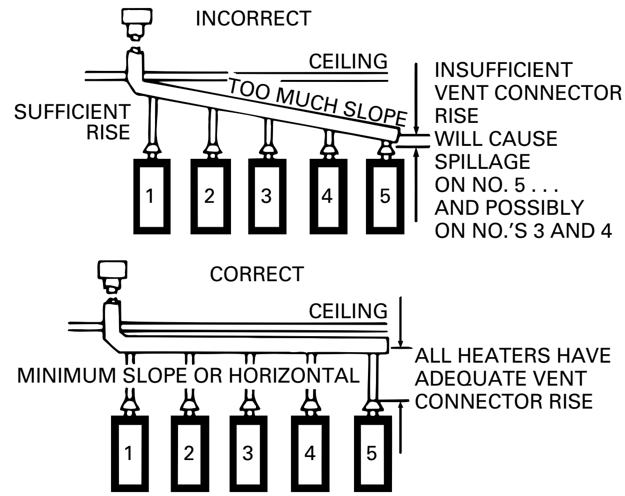


Figure 22

As shown in Figure 22, a manifold may be either horizontal or sloped. Excessive slope does not improve venting and can cause problems. Many codes specify a slope of l/4 inch per foot, sloped upward from the appliance to the common vent. Where local codes require sloped manifolds, all the appliance connectors must have the minimum acceptable rise for proper venting.

The designer of manifold vent systems must use careful judgment when selecting which type of manifold to use. There are not any "rules-of-thumb" regarding manifold type selection. Common sense and reasoning are a vent designer's greatest assets.

For example, when manifolding medium efficiency furnaces (78% to 83% AFUE), a tapered manifold will work better than a constant size manifold. Less material means less heat loss. Second, there is less internal area, so there is less room for dilution when any of the furnaces are inactive. This prevents premature cooling and condensation of the flue products.

Multi-Story Vent Systems

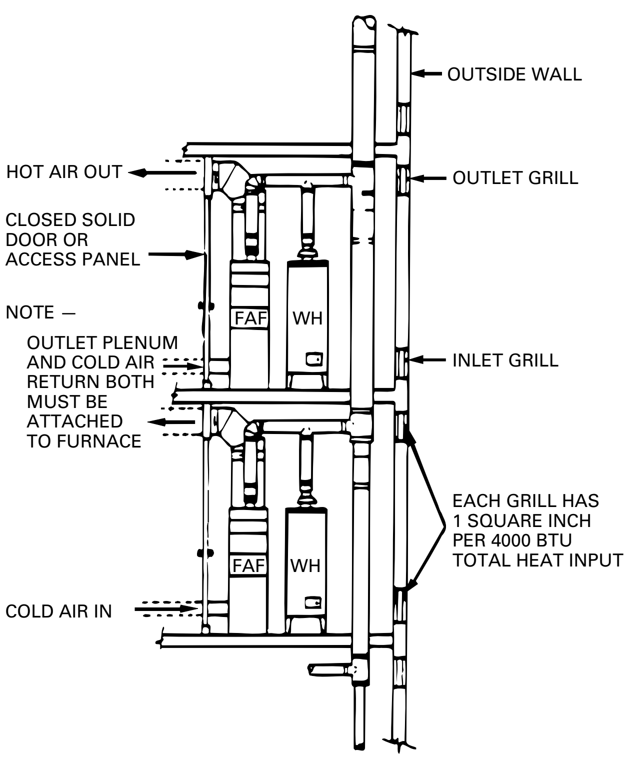
Multi-story common vent systems are similar to manifold vents. However, each appliance may be on a different floor. Thus, as shown in Figure 23, they enter the common vent at different levels. The connector and vent must be designed so that they perform properly with only one appliance operating or any combination of appliances in operation. In design of multi-story vents, it is important to separate the gas appliances from occupied spaces. In this way, no flue-gases will enter the occupied space if the common vent were to become blocked at any level. In the remote case that blockage occurs, all appliances below the blockage will vent through the draft hood relief openings of the unit just below the blockage. Combustion products will be dumped into the space containing the appliances. Appliances operating at levels below the blockage could appear to be operating normally, when they may all be spilling combustion products at a higher level.

Even when appliances are isolated from the occupied area, air must be provided to each appliance. The air supply serves three major functions:

1. Combustion air for burning gas (primary, secondary and excess)
2. Draft hood dilution air (when required)
3. Ventilation air to avoid heat build-up

Relying on infiltration for ventilation air is a poor practice in multi-story applications. This is because the inner-most quarters within a structure will typically have fewer exterior doors and windows. Also, today's construction methods are producing much “tighter” buildings. The practice of locating gas fired equipment in a central hallway and using the hallway for ventilation should not be done. Figure 23 shows a practical method of locating appliances in a separate room with ventilation air grills on the outside wall.

Sometimes it is not practical to build a separate equipment room with an adjacent outside wall. If this is the case, the vent system designer should also design a duct system to supply outside air to the gas appliances. Several methods for supplying outside air are discussed in the section on ventilation air.



OUTSIDE WALL AIR SUPPLY FOR SEPARATED HEATING ROOM

Figure 23

Sizing and Design

The section on furnace categories discussed the difference in the venting characteristics of the separate categories.

This section on sizing and design covers first how to accurately size and design vent systems for Category I furnaces. Also in this section are some recommended procedures for venting Categories II, III, and IV.

Category I

Sizing vent systems for Category I furnaces is accomplished by applying known information to capacity tables developed by the AGA (American Gas Association) or the National Fuel Gas Code. Before referring to the capacity tables, the designer must do some planning and fact gathering.

The designer needs to know how and where the flue products are going to be expelled from the structure. Is the furnace going to be vented through a masonry chimney? Will there be a metal vent going through the roof? Is the chimney located on an inside wall or an outside wall?

The designer should also take into consideration the orientation of the building. Will the vent terminate on the side of the building which is exposed to prevailing winter winds? Are there any adjacent buildings which are taller than this one? These factors can have an effect on down-draft conditions.

The designer must also measure the distance from the furnace location to the vent or chimney location. This will be the lateral connector length. The height of the vent or chimney must be measured. Figure 24 illustrates the points where these measurements are made.

The last bit of information needed is type of the furnace (natural draft or fan assisted) and the BTUH input of the furnace(s) being served by the vent. Armed with this data, the designer can now use the capacity tables to size vents for Category I furnaces.

Sizing For A Single Unit Using A Masonry Chimney

When attaching a gas appliance to an existing masonry chimney, the size of the chimney must be checked to make sure the flow will not overload it. On the other hand, the chimney must not be too large. Use the formula þ D^2 x 7 ÷ 4 = MAX (3.1416 times the diameter of the flue collar squared times 7 divided by 4 = maximum area) to determine the upper limit of the flow area. Fortunately, the minimum and maximum limits are shown at the bottom of theTable listing the Masonry chimney sizes.

Table 6 (See Appendix for tables) is used to determine capacity of masonry chimneys serving a single appliance using a single-wall connector. Single fan assisted furnaces may not be installed in a masonry chimney without a metal liner.Table 8 gives values for chimney capacities with single-wall vent connectors serving two or more appliances. These tables contain a factor to allow two elbows used in the construction of the vent connectors. If more are required, reduce the maximum capacity by 10% for each added elbow. Table 9 lists circular equivalents for masonry chimney liners.

A fan assisted furnace may only be vented into a masonry chimney with a tile liner, provided the chimney is an internal chimney within the structure **and** there is another natural draft appliance also vented into the chimney.

As an example, consider the installation of a natural draft gas furnace with an input rating of 100,000 BTUH. The available chimney height is 20 feet, and the lateral for the connector is five feet. Table 6, (See Figure 25), shows that a five-inch

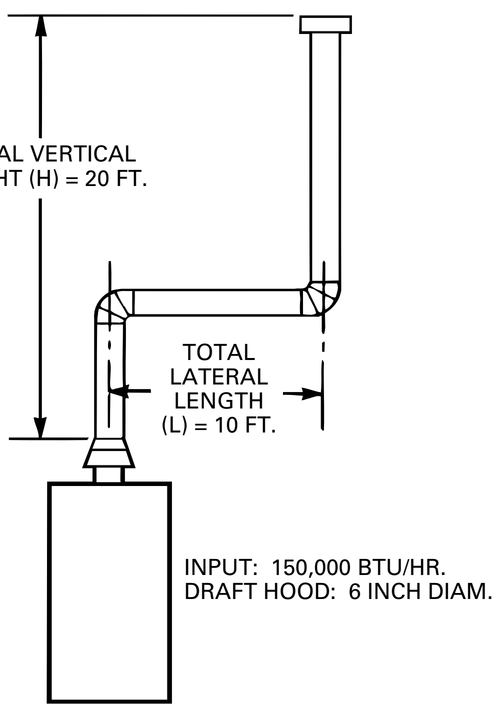


Figure 24

Capacity of Masonry Chimney with Single-Wall Vent Connectors Serving a Single Category I Appliance

TABLE 6		Connector Diameter – D (inches) To be used with chimney areas within the size limits at bottom											
		3"			4"			5"			6"		
		Appliance Input Rating In Thousands of BTU Per Hour											
Height H (ft.)	Lateral L (ft.)	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	N M
6	2	NR	NR	28	NR	NR	52	NR	NR	86	NR	NR	1
	5	NR	NR	25*	NR	NR	48	NR	NR	81	NR	NR	
10	2	NR	NR	31	NR	NR	61	NR	NR	102	NR	NR	
	5	NR	NR	28*	NR	NR	56	NR	NR	95	NR	NR	
	10	NR	NR	25*	NR	NR	49*	NR	NR	86	NR	NR	
15	2	NR	NR	35*	NR	NR	67	NR	NR	113	NR	NR	
	5	NR	NR	32*	NR	NR	61	NR	NR	106	NR	NR	
	10	NR	NR	27*	NR	NR	49*	NR	NR	96	NR	NR	
	15	NR	NR	NR	NR	NR	46*	NR	NR	87*	NR	NR	
20	2	NR	NR	38*	NR	NR	73	NR	NR	123	NR	NR	
	5	NR	NR	35*	NR	NR	67*	NR	NR	115	NR	NR	
	10	NR	NR	NR	NR	NR	59*	NR	NR	105*	NR	NR	1
	15	NR	NR	NR	NR	NR	NR	NR	NR	95*	NR	NR	1
	20	NR	NR	NR	NR	NR	NR	NR	NR	80*	NR	NR	14
Minimum Internal Area of Chimney Square Inches		12			19			28			38		
Maximum Internal Area of Chimney Square Inches		49			88			137			198		

* SEE Note 27

This table is extracted from table on page 35.

Figure 25

connector can be used and the chimney must have an internal minimum cross-sectional area of 28 square inches. Referring to Table 9, note that a 4 x 8 flue liner has only 12.2 square inches of equivalent area. An 8 x 8 liner has 42.7 square inches area, therefore, the liner should be a nominal 8 x 8 inch size to accommodate this furnace. Similarly, the size of masonry chimneys can be determined for two or more appliances using Tables 6 and 9.

Most often, the vent designer is not involved in the chimney construction. The designer and builder of the structure take care of that. The vent system designer's responsibility is to check the chimney construction for proper size, suitable lining, and to make certain that the chimney cannot be used for any appliance which burns solid fuels. If the chimney once served a fireplace, **the fireplace opening must be permanently sealed.** If the owner of the building wants to keep the fireplace open for use, then the chimney may not be used to vent the gas furnace. A separate vent must be installed.

Sizing A Single Appliance Type B Vent

Category I furnace vent systems are designed using the capacity tables found the Appendix in the back of this manual. The same tables are found in the appendices of the **National Fuel Gas Code** (NFPA54/ANSIZ223.1).

Table 1 in this manual is used to size vent systems for a single Category I furnace using Type B vents and connectors. Table 2 is used for sizing vents for a single furnace using single-wall connector vent pipe material.

How to use the Single Appliance Type B Vent Table (Table 1).

For this example, refer to Figure 24 on Page 11 and Figure 26.

Capacity of Type B Double-Wall with Type B Double-Wall Connectors
Serving a Single Category I Appliance

TABLE 1		Vent and Connector Diameter – D (inches)													
		3"			4"			5"			6"			7"	
		Appliance Input Rating In Thousands of BTU Per Hour													
Height H (ft.)	Lateral L (ft.)	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Ma
6	0	0	78	46	0	152	86	0	251	141	0	375	205	0	52
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	32
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	[illegible]
	6	25	46	33	36	91	61	47	149	100	59	223	149	78	[illegible]
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	[illegible]
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	[illegible]
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	[illegible]
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	[illegible]
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	[illegible]
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	[illegible]
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	[illegible]
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	[illegible]
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	[illegible]
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	47
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	46
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	44
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	42
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	77
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	53
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	51
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	[illegible]
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	[illegible]
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	[illegible]
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	

This table is extracted from table on page 32.

Figure 26

1. Determine the total height (H) and total lateral length (L) needed for the vent.
2. In Table 1, read down the (H) column to the proper total height.

   * Go down total vent height column to 20 feet (Figure 26).
3. In the (L) space to the right of the correct (H), pick the proper lateral length (use zero for straight vertical vents which have no elbows).

   * Read down the next column (L) to a length of lateral of 10 feet.
4. Read across the selected (L) row to the column which shows a capacity equal to or just greater than the appliance nameplate BTUH input rating under "Nat. Max." The reading will be in thousands of BTU'S per Hour.

   * Read to the right across (L) = 10 feet row until 150 is found. You are under the 5 inch vent size column.
5. 100,000 BTUH is equal to the furnace input. A 4 inch vent only has 89,000 BTUH capacity – too small. A 6 inch vent has a capacity of 228,000 BTUH – much too large. Use the five inch vent.

Downsizing from the flue collar size

Even though a flue collar provided on the furnace is a six inch diameter, a five inch vent can be used if the following conditions are met. **First, local code has to allow sizing vents smaller than the flue collar. Second, the total vent height must be ten feet or more. Third, if a fan assisted furnace is used, reduce the maximum rating by 10% (0.90 X maximum capacity).** A note of caution: Vents for equipment with a draft hood of 12 inch diameter or less should not be reduced more than one pipe size. A 12 inch to 10 inch reduction is one pipe size. **There is one case where downsizing a natural draft furnace vent should not be done. Never attach a three inch vent to a four inch flue collar. This does not apply to a fan assisted furnace.**

Values between Table values

In many cases, the vent system will have total vent height(H) and lateral length(L) values in between the table values. To evaluate these situations, the fractional difference between the next largest and the next smallest is used.

Example: Heights and laterals in between table values.

Figure 27 represents a furnace for which we are to determine the proper vent size. The natural draft furnace input rating is 100,000 BTUH with a 5 inch draft hood.

Procedure – (refer to Figure 28)

1. (H) = 20 feet and (L) = 13 feet.
2. Go down total vent height column to 20 feet.
3. Under 5 inch vent size, "NAT Max"
   15 feet lateral shows 142,000
   10 feet lateral shows 150,000
4. Since 13 is 3/5 of the way between 10 and 15, to

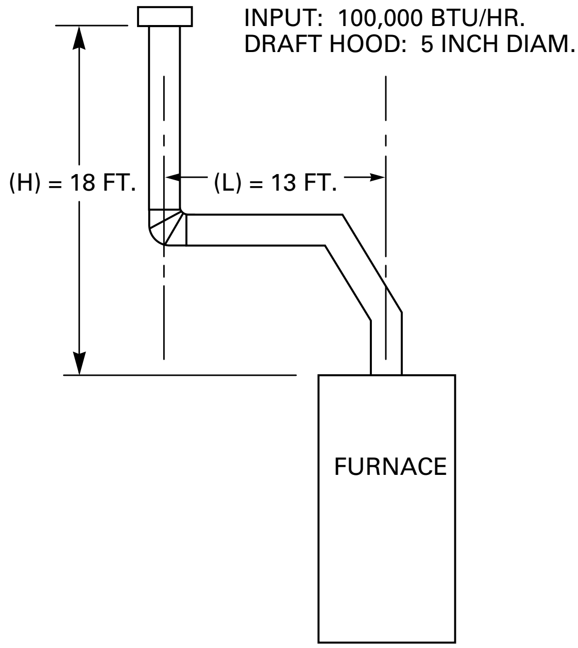


Figure 27

Capacity of Type B Double-Wall with Type B Double-Wall Connectors Serving a Single Category I Appliance

TABLE 1		Vent and Connector Diameter – D (inches)												
		3"			4"			5"			6"			7"
		Appliance Input Rating In Thousands of BTU Per Hour												
Height H	Lateral L	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN
(ft.)	(ft.)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Ma
6	0	0	78	46	0	152	86	0	251	141	0	375	205	0	52
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	32
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	31
	6	25	46	33	36	91	61	47	149	100	59	223	149	78	3
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	5
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	3
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	3
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	[illegible]
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	6
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	4
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	3
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	3
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	71
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	47
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	46
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	44
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	42
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	77
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	53
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	51
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	49
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	4
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	4
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	

This table is extracted from table on page 35.

Figure 28

find the size for 13 feet of lateral, we take 3/5 of the difference:

8,000 x 3/5 = 4,800

... subtract the result from the 150,000 for 10 feet of lateral (we lose capacity with a longer lateral):

150,000 – 4,800 = 145,200

145,200 BTUH is the table capacity for 13 feet of lateral and 20 feet height.

Therefore, a 5 inch vent would handle 145,200 BTUH input to the furnace.

Since the furnace input in this example is 100,000 BTUH, the 5 inch vent will do the job.

The same procedure would allow you to calculate heights which are not shown on the Tables. Remember that higher vents increase capacity.

"Fan Assisted" Vent Sizing

Throughout this manual the distinction between the "natural draft" and "fan assisted" furnaces has been stressed, although we have learned they are both Category I furnaces. Now, it is time to see what difference this design change makes in the vent sizing decision. We will examine the same example that was just used to select the vent size for the 100,000 BTUH natural draft furnace. This time we will select a "fan assisted" model.

Procedure – (Refer to Figure 28)

1. There is no change in the installation specifications. The height is the same, 20 feet, and the lateral distance is 13 feet.
2. Go down the total vent height column "H" to 20.
3. In the length of lateral "L" space to the right, find 15 feet. On this row, look under 3" vents. There are three ratings shown. The maximum "FAN" rating shows only 58. That's only 58,000 BTUH. Not enough. But look closely, there is a minimum rating shown on that line also. The minimum is 34,000 BTUH. Each fan assisted furnace will show both a maximum and minimum rating in order to help control condensation in the vent pipe.

   Look under the 5" column. The rating jumps to 217,000 but the minimum is still below our furnace input of 100,000. We could use this size of vent. Is it a good choice? Not if you must pay the bill for the vent. Let's see what the 4" vent size will handle. The largest furnace that it could serve is 124,000 BTUH. That's more than we need. The minimum is 46,000 BTUH and we have more than that. We're almost through.
4. To determine the size for an 13 foot lateral:

   13 is 3/5 of the difference between 10 and 15.

   Go down the "H" column to 20 feet. In the "L" space, find 10 feet. On this row, look under 4" and see 133 Fan max.

   Find the difference between the rating for 10 and 15 feet.

   133,000 – 124,000 = 9,000

   Since 13 is 3/5 the difference between 10 and 15, then we find 3/5 of 9,000.

   9,000 x 3/5 = 5,400

   Subtract the result from the 133,000

   133,000 – 5,400 = 127,600

   127,600 BTUH input is the maximum capacity of a 4 inch vent having 20 feet of height and 13 feet of lateral. The minimum could be figured in the same way.

Since the furnace input in the example is 100,000 BTUH, the 4 inch vent will work on this type of furnace. In this example when compared to natural draft, the result was changed from 5 to 4 inch vent pipe. By trying other combinations of height and lateral offset, you will soon see that the result could have been quite different.

For appliances with more than one input rate, the minimum vent or connector (Fan Min.) capacity determined from the tables shall be less than the lowest appliance rating and the maximum vent or connector capacity determined from the tables shall be greater than the highest appliance input rating.

Multiple Appliance Vent Systems

Any vent system, venting two or more appliances on the same floor into a common vent, is a multiple or combined appliance vent system. The minimum (shortest) total height is the vertical distance from the highest appliance draft hood outlet to the top of the vent. This dimension is the same regardless of the number of appliances. The vent connector rise for any appliance is the vertical distance from its draft hood outlet to the point where the next connector joins the system. The common vent is the portion of the vent system above the lowest interconnection. The sizes of the individual connectors are found from Table 4a and the size of the common vent from Table 4b. See Figure 30.

How to Size A Multiple Vent System

The Tables relating to common venting were constructed with an assumption which you must remember. They assume the connector leading to the vent will never exceed a length greater than the connector diameter in inches times one and one half feet. In other words, for each inch of connector diameter, the length must not exceed 18 inches. A four inch diameter connector must not be longer than six feet. (4 x 18 = 72 inches = 6 feet)

What happens if you go beyond this length? Does the vent quit working? NO! You must just remember to de-rate the connector's capacity, that's all. Each time you add on, up to the connector's original length, take away 10% of the maximum capacity. For 7 to 12 feet of 4" connector, use only 90% of maximum capacity. For 13 to 18 feet, de-rate by 20%, as you have three times the original length. As you have always been told, keep it as short as possible.

First, determine size of each vent connector.

1. Determine the minimum (shortest) total height of the system. See Figure 29 for measuring points.
2. Determine the connector rise for each appliance.
3. Using Table 4a, find the vent connector size for each appliance. Enter the table at the selected minimum total height. Read across to the connector rise for the first appliance and continue across the proper connector rise row to the appliance input rating. Read the vent connector size at the top of the column with the correct input rating.

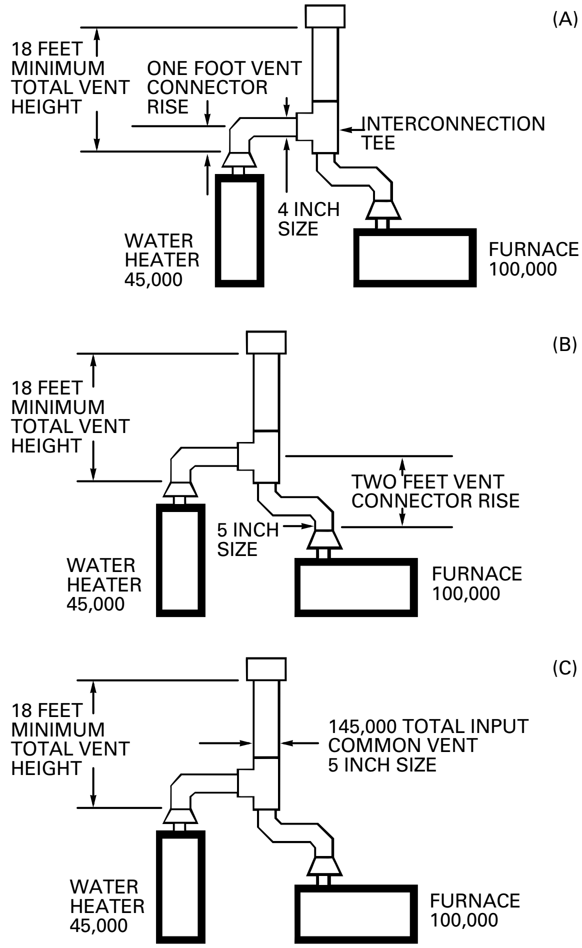


Figure 29

4. Repeat Step 3 for each appliance.

Determining Size Of Common Vent

As we look at the common vent tables, there are three columns under each heading. They are: "Fan + Fan", "Fan + Nat" and "Nat + Nat". The numbers reflect the maximum input combination of fan assisted and natural draft appliances which may be used. If you must use an existing natural draft water heater with a new fan assisted furnace, choose the center column. Two natural draft products, use the right hand column, etc. If the letters "NR" appear, that choice of vent and product are not recommended.

1. Add together the input ratings of all appliances in the multiple vent system.
2. Enter the common vent Table 4b at the total height value used above.
3. Continue across to the first value that equals or exceeds total input ratings.
4. Read the size of the common vent needed at the top of this column.
5. **CAUTION:** Regardless of the result, the common vent must always be as large as the largest connector. If two or more vent connectors are the same size, the common vent must be at least one size larger.

Typical Example

Example: To size a multiple appliance vent refer to Figures 29 and 30: Connect a 45,000 BTUH water heater with a 1 foot vent connector rise and 100,000 BTUH furnace with a 2 foot vent connector rise to a common vent with a minimum total vent height of 18 feet. The water heater is within 5 feet of the common vent and the furnace is only four feet away.

Capacity of Type B Double-Wall Vent with Single-Wall Connectors Serving Two or more Category I Appliances

TABLE 4		Vent Connector Diameter – D (inches)												
		3"			4"			5"			6"			
		Appliance Input Rating In Thousands of BTU Per Hour												
Vent Height H	Connector Rise L	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	
(ft.)	(ft.)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	M
6	1	NR	NR	26	NR	NR	46	NR	NR	71	NR	NR	102	2
	2	NR	NR	31	NR	NR	55	NR	NR	85	168	182	123	2
	3	NR	NR	34	NR	NR	62	NR	NR	95	174	198	138	2
15	1	NR	NR	29	79	87	52	116	138	81	177	214	116	2
	2	NR	NR	34	83	94	62	121	150	97	185	230	138	24
	3	NR	NR	39	87	100	70	127	160	109	193	243	157	25
30	1	47	60	31	77	110	57	113	175	89	169	278	129	22
	2	50	62	37	81	115	67	117	185	106	177	290	152	236
	3	54	64	42	85	119	76	122	193	120	185	300	172	244
50	1	46	69	33	75	128	60	109	207	96	162	336	137	217
	2	49	71	40	79	132	72	114	215	113	170	345	164	226
	3	53	72	45	83	136	82	119	221	128	178	353	186	235

Common Vent Capacity

	Common Vent Diameter – D (inches)									
	4"			5"			6"			
Vent Height	Combined Appliance Input Rating In Thousands of BTU Per									
H (ft.)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	F +F
6	89	78	64	136	113	100	200	158	144	3
8	98	87	71	151	126	112	218	173	159	33
10	106	94	76	163	137	120	237	189	174	35
15	121	108	88	189	159	140	275	221	200	416
20	131	118	98	208	177	155	305	247	223	463
30	145	132	113	236	202	179	350	286	257	533
50	159	145	128	268	233	204	406	337	296	662

This table is extracted from table on page 34.

Figure 30

The three-step procedure for working this example is as follows:

(A) Determine Water Heater Vent Connector Size
See Figure 29A.

Procedure:

1. Use the multiple appliance Vent Connector Table 4a.
2. Read down Total Vent Height column to 15 feet. Read across 1 foot Connector Rise line to BTUH rating equal to or higher than water heater input rating. The figure shows 52,000 BTUH and is in the column for a 4 inch connector.
3. Since 52,000 BTUH is in excess of the water heater input rating, it is not necessary to find the maximum input rating for an 18 foot minimum total vent height. Use a four inch vent connector.

(B) Determine Furnace Vent Connector Size
See Figure 29B.

Procedure:

1. Refer to Vent Connector Table 4a.
2. There is no Total Vent Height column for 18 feet; therefore, work from 15 foot and 30 foot columns.
3. Read down Total Vent Height column to 15 feet; read across 2 foot Connector rise line. 5 inch vent size shows 97,000 BTUH, or less than furnace input. Repeat step, using 30 foot column, 2 foot Connector rise line. Here the 5 inch vent size shows 106,000 BTUH.
4. 18 feet is 1/5 the difference between 15 feet and 30 feet. The difference between 97,000 and 106,000 is 9,000. 1/5 of 9,000 is 1,800. Add 1,800 to the 15 foot figure (97,000) = 98,000 BTUH.
5. 98,800 BTUH is the maximum input for 18 foot minimum total vent height.
6. A 5 inch connector would be the correct size for the furnace, providing the furnace had a 5 inch or smaller draft hood outlet.

(C) Determine Common Vent Size
See Figure 29C.

Procedure:

1. Refer to Common Vent Table 4b.
2. There is no Total Vent Height column for 18 feet; therefore, work from 15 foot and 20 foot columns.
3. The total input to the vent is 145,000 BTUH.
4. 15 feet maximum BTUH for 5 inch vent is 140,000 20 feet maximum BTUH for 5 inch vent is 155,000.
5. 18 feet is 3/5 the difference between 15 feet and 20 feet. The difference between 140,000 and 155,000 is 15,000. 3/5 of 15,000 is 9,000. 140,000 + 9,000 = 149,000 BTUH, which is greater than total input to common vent.
6. Therefore, the common vent can be 5 inch diameter pipe. See Figure 30.

Multi-Story Vent Systems

Multi-story vent systems of any height can be sized using the multiple appliance vent Tables 4a and 4b. These tables are best suited to appliances separated from occupied areas such as boilers on porches or furnaces and water heaters in closets. The system will function satisfactorily when any one or all appliances are operating.

When designing a multi-story vent system, the following principles should be applied:

1. The overall system should be divided into smaller, vent systems for each level, each using a total vent height for each level as shown in Figure 31 on page 18. Principles of design of multistory vents using vent connector and common vent design table.
2. Each vent connector from the appliance to the verti-

cal common vent should be designed from the vent connector table, as in multiple appliance vent systems.

3. For sizing of the vertical common vent, the common vent table is used. The vertical common vent for each system must be sized large enough to accommodate the accumulated total input rating of all appliances discharging into it, but should never be smaller in diameter than the largest section below it.

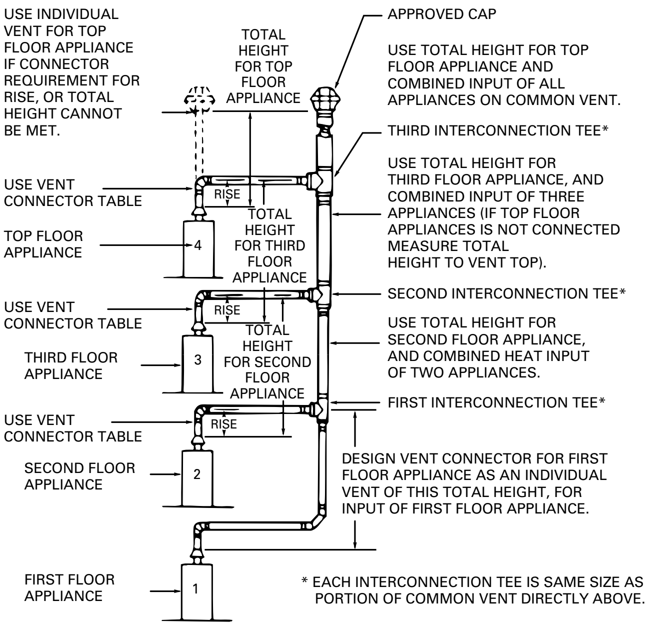


Figure 31

4. The vent connector from the first floor or the lowest appliance to the common vent is designed as if terminating at the first tee or interconnection. The next lowest appliance is considered to have a combined vent which terminates at the second interconnection. The same principle continues on to the highest connecting appliance with the top floor appliance having a total vent height measured to the outlet of the common vent.

5. The multi-story system has no limit in height as long as the common vent is sized to accommodate the total input rating.

Precautions in Designing Multi-Story Vent Systems

1. The common vent portion of the system must be vertical with no offsets to use the values in the Tables without de-rating.
2. Common vent height must always be computed as the distance from the outlet of the draft hood to the lowest part of the opening from the next interconnection above.
3. If the vent connector rise is inadequate, increase vent connector size, always making use of maximum available vent connector rise.
4. Be sure that the ventilation air supply to each appliance is adequate for proper operation. A furnace must be enclosed in a separate room from the living area and a permanent provision for outside air supply is necessary.
5. If an air shaft or chase is used for installation of the common vent, be sure that sufficient space is provided for fittings, clearance to combustibles and access for proper assembly.

Common Vent Calculations – Four Floors

Appliance	Total Input to Common Vent	Available Connector Rise	Total Vent Height	Connector Size	Common Vent Size
1	90,000	10′	10′	5″	5″
2	180,000	1′	10′	6″	7″
3	270,000	1′	10′	6″	8″
4	360,000	1′	6′	6″	10″

Table A

Common Vent Calculations – Separate Top Floor

Appliance	Total Input to Common Vent	Available Connector Rise	Total Vent Height	Connector Size	Common Vent Size
1	90,000	10′	10′	5″	5″
2	180,000	1′	10′	6″	7″
3	270,000	1′	16′	6″	6″
4	90,000	8′	6′	5″	5″

Table B

6. The capacity tables apply only when the entire system is constructed of listed double-wall Type B Vent materials.

Example: Figure 31 shows a typical example of a multi-story vent system.

1. Assume Figure 31 represents a 4-story apartment.
2. Each appliance has a 90,000 BTUH input rating.
3. Each appliance has a 5 inch draft hood.
4. Total vent height is 10 feet for each of the three lower floors.
5. Total vent height is 6 feet for the top floor.
6. Use Table 4b for sizing common vent.

Table A shows the calculation for venting all four floors into the common vent.

However, if the furnace on the top floor is vented separately, Table B shows the results of increasing the minimum total vent height of the third floor appliance to 16 feet and decreasing total input to common vent to 270,000 BTUH. Table B indicates the economics of venting the top floor separately. This eliminates the larger sizes of vent pipe and the use of extra, costly fittings.

Vents in High Altitude Locations

Vent systems should be designed on the basis of the sea level input rating. For multiple appliance inputs, design the vent using the greatest possible sea level input rating.

When a gas appliance is derated due to altitude, the volume flow of fuel gas required will be less than at sea level. However, the volume of air required for furnace operation is not that much less. This is because the air becomes less dense as the altitude increases. Because of the lower density, a higher ratio of air to gas is required to supply enough oxygen.

Power Venting

If the steps outlined in the previous sections are followed carefully, the vent will perform well. Sometimes, however, there are factors which cannot be overcome, such as extremely high prevailing winter winds. Also, especially in retro-fit applications, sometimes it isn't convenient or even possible to redesign an improperly sized vent. Sometimes the furnace may be poorly located, requiring several elbows. Power venting is a good solution to many venting problems.

A power assisted vent system has a fan, blower, or booster, see Figure 32, located within the vent system. The power assist (draft inducer) can be located anywhere in the vent, but locating it at the vent outlet is preferable. If the furnace is "Fan Assisted", a barometric relief damper must be installed at the appliance flue outlet to prevent the power vent from pulling the products of combustion through the heat exchanger. With a negative vent pressure, any leaks in the vent will be inward. The air around the vent will be pulled into the vent rather than the flue-gases being forced out of the vent.

A power assist installed in a vent can increase the capacity of the vent up to four times. The amount of capacity increase depends on the strength of the assist and the size of the vent. Exact sizing information for power assists can be obtained from the manufacturer.

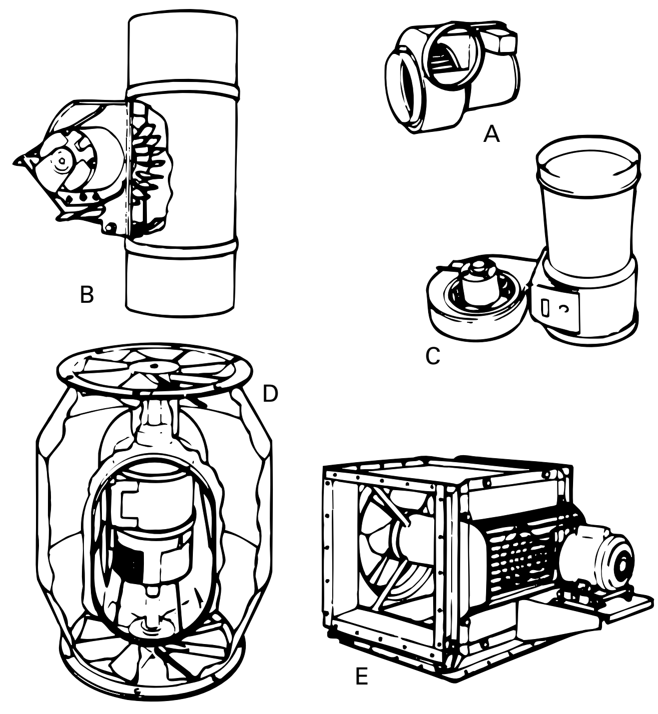


Figure 32

Category II

As mentioned earlier, Category II furnaces are classified as non-positive with flue-gas temperatures less than or equal to 140°F above their dew-point. Extreme care must be taken when designing vents for these furnaces. There are several special considerations involved.

Flue-Gas Temperature

The temperature of the flue-gases from a Category II furnace can be expected to be somewhere around 275°F or less. Existing vent sizing tables are based on the assumption that the flue-gases entering the vent are at a temperature of 360°F or higher. Because Category II furnaces produce lower temperature flue-products, existing tables may not apply. The volume of gases being produced by these products will be less than in lower efficiency models; therefore, the vent pipe size could possibly be smaller than indicated by existing sizing tables.

Until research yields specific tables for these types of products, the furnace manufacturer's instructions are the only basis available for designing vents for Category II products.

Condensation

Because of the lower temperature flue-gases produced, there is a good chance condensation will occur inside the vent. As a result, the **National Fuel Gas Code** suggests the use of a corrosive resistant vent material such as stainless steel or aluminum coated stainless steel.

While the piping may be more expensive initially, it will be less expensive than several repairs on a less corrosive resistant material.

It is also recommended that a "drip Tee" be placed in the vent connector at a location near the furnace. If proper slope is maintained on the lateral sections of the vent, condensate will drain into the "drip Tee" and can be drained via a hose to a nearby drain approved by local authorities.

"Drip Tee's" or "drain Tee's" are available through many vent pipe manufacturers.

Power Venting

The designer of vents serving Category II furnaces should probably consider the use of some kind of power assist in the vent. Because of the lowered flue-gas temperatures, the draft forces produced by these furnaces are also reduced. There is no room for error with these furnaces. A vent system of a "marginal" size and design will often operate improperly.

If power venting is chosen, there are a couple of recommended procedures. First, the draft inducer should be located at or near the vent outlet. Installing it at the outlet causes the vent to operate under negative pressure. In this way, any leaks in the vent will be inward. The air around the vent will be pulled in rather than the flue-gases being pushed out. Secondly, no matter where the power assist is located, the vent system should be sealed. Seams and joints can be sealed either using a high temperature, silicone-rubber sealant or with pressure-sensitive, foil-backed tape.

Generally, good common sense practices will go a long way toward successful venting of Category II furnaces. If the designer will maintain proper slope, limit the number of elbows, insulate the vent in cold spaces, the additional steps outlined in this section can help to ensure proper vent performance.

Category III

Category III furnaces are distinguished by positive vent pressure and flue-gas temperatures greater than or equal to 140°F above their dew-point. Getting the flue-products to the outside of the building is really no great problem. The positive pressure classification means that the combustion by-products will be "pushed" out of the vent. Furnace manufacturers accomplish this through the use of blowers attached to the heat exchanger outlet or by the use of pulse combustion systems. A special case is created when 78 to 83% AFUE induced draft furnaces are vented horizontally.

The higher flue-gas temperature minimizes the danger of harmful condensation occurring inside the vent. Therefore, there is no need for a special corrosion resistant vent pipe material. However, if UL listed high temperature plastic is used in the vent, a drain Tee must be installed due to the high heat loss and subsequent condensation. This will occur when venting 78 to 83% AFUE induced draft furnaces horizontally.

The prime consideration when venting Category III furnaces is the positive vent pressures. In order to prevent leakage of flue products into the indoor atmosphere, the vent system should be assembled in a leak-proof manner. Again, the recommended sealing method is with high temperature silicone rubber. In some cases, foil-backed tape may be used. Check the manufacturers instructions and local codes.

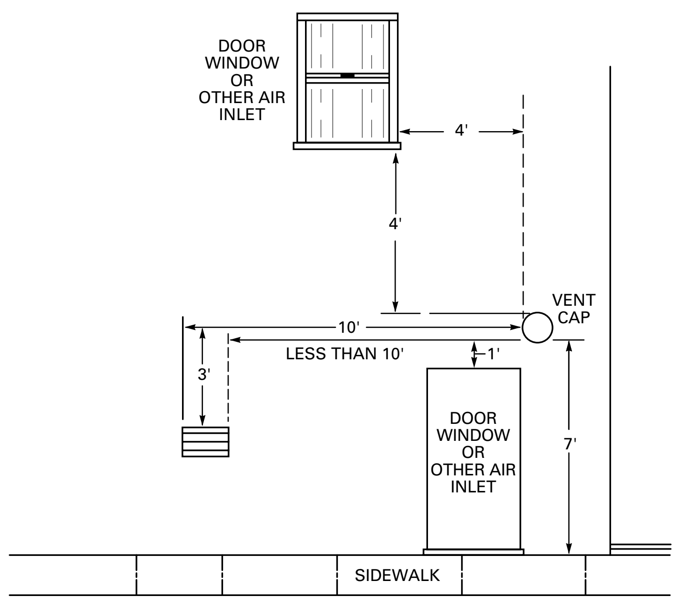
Sizing

Because these furnaces are forced draft, sizing of the vent pipe is not usually left up to the vent designer. The furnace manufacturer normally includes information which will be used to determine the vent design. Usually, the vent pipe will be the same diameter as the flue connector/adapter of the unit. The design information will cover the maximum amount of lateral run which is allowed when a certain number of elbows are used.

Termination

Positive pressure furnaces such as Category III and Category IV furnaces are suitable for termination through a wall. The vent should not, however, terminate through a wall which is directly exposed to the prevailing winter wind. If the wind is strong enough, it may overcome the draft produced by the forced draft blower or pulse combustion system. Also, the terminal should not be located where there is no wind. "Dead corners" allow the vented flue-gases to accumulate.

When venting through a side wall, care must be taken to ensure that the flue-products cannot reenter the building. It is also necessary to locate the vent terminal above the normal level of snow or ice accumulation. Be wary of the possibility of snow drifts on the leeward side of a building.



The cap must be a least 7' above grade, if it is adjacent to public walkways.

Avoid areas where ataining or condensate drippage may be a problem.

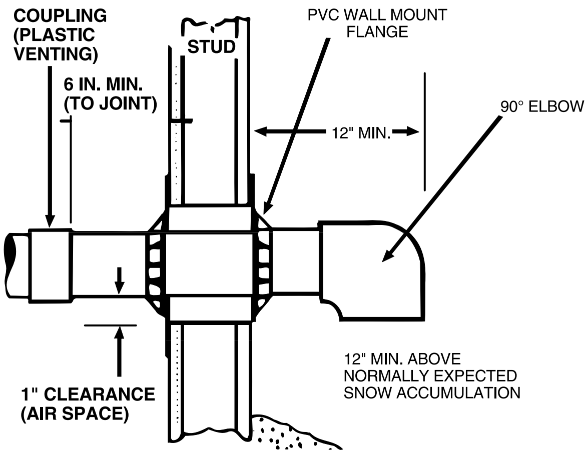
The vent/wind cap must terminate at least 3' above any forced air inlet into the building that is within 10' of the cap. The cap must also terminate 4' below, 4' horizontal from or 1' above any door, window or other air inlet into building.

Diagram of sidewall terminal location for condensing model furnaces.

Figure 33

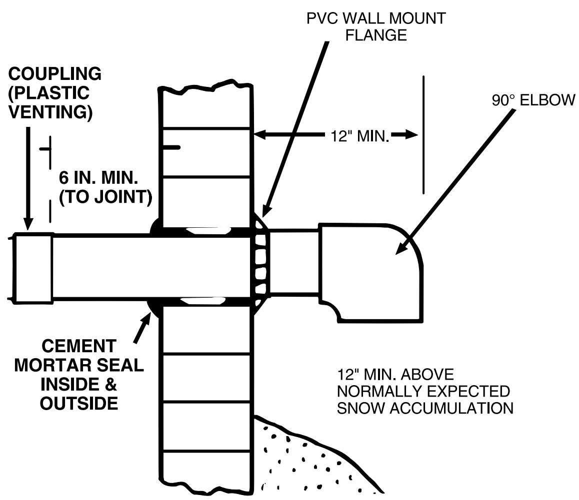
Consult local authorities or the owner of the building on matters such as snow accumulations.

Figure 33 illustrates clearances for side-wall terminals used



Venting Through Combustible Walls
Pitch – 1/4 Inch Per Ft.

Clearance (0" acceptable for
PVC vent pipe) (1" acceptable
for type 29-4C stainless steel vent pipe).



Venting Through Non-Combustible Walls
Pitch – 1/4 Inch Per Ft.

Figure 34

near entrances into a building.

Figure 34 is a diagram showing two methods of side-wall termination above the expected level of snow accumulation.

Category IV

Category IV furnaces - “90+” AFUE models - are characterized by positive vent pressure and flue-gas temperatures less than or equal to 140°F above their dew-point. These are super high efficiency models which condense water vapor from the flue products in order to recapture heat. Venting these furnaces is very similar to venting Category III products with a few small differences.

Vent Pipe

The vent pipe for these products must be corrosion resistant. Although the furnace condenses water vapor out of the flue gasses, not all of the water vapor is condensed. Many manufacturers are recommending the use of PVC or CPVC plastic pipe. This pipe may be used because of the low flue-gas temperatures. If metal pipe is desired, Allegheny Steel type AL29-4C stainless steel pipe is recommended. Type AL29-4C stainless steel is a high quality metal formulated specifically for resistance to acids.

Condensate

Category IV furnaces usually include, in the design, some method of removing and draining the condensed water vapor. Because of this, it should not be necessary to provide any kind of “drip Tee” or “drain Tee” in the vent. However, it is vital that all vent pipe slope **toward** the furnace. Any condensate, which may form inside the vent, will run back to the furnace. The furnace condensate disposal system can then take care of it. Also, it is important that the vent pipe be installed with the male ends of the pipe and fittings toward the furnace. This prevents the possibility of the condensate collecting at the “lip” formed where the pipe is inserted into couplings and fittings.

Vent Design

Since these furnaces incorporate some kind of forced draft system, the pipe sizing is done by the manufacturer. The vent designer must stay within the limitations of lateral lengths and number of elbows which are contained in the furnace installation instructions.

Combustion and Ventilation Air

As previously mentioned, gas furnaces require a substantial amount of fresh air for proper operation. In the past, this air would make its way to the furnace by way of infiltration. Older construction methods allowed a considerable amount of air leakage around doors, windows, etc. With today's increasing energy efficiency awareness, buildings are being built "tighter". Caulking, weatherstripping, and otherwise sealing a structure has been the first major step toward making it more energy efficient. These practices reduce the likelihood of enough air infiltrating into the building.

The following guidelines present design considerations and procedures for ensuring an adequate air supply to the gas furnace.

The method of supplying air to the furnace is just as important as supplying enough air. Makeup air for exhaust fans should not come from the same space in which the furnace is located. For example: If the furnace is located in a ventilated basement or crawl space, the building's makeup air supply should come from elsewhere. Otherwise, the furnace and the makeup air system may have to compete for the air in the basement. This may cause "starvation" of the furnace. A negative pressure condition may even arise in the basement. The furnace draft will be affected resulting in spillage of combustion products at the furnace draft hood.

Since the makeup air supply comes from the basement, in this example, flue products may also be pulled into the building's conditioned air supply. The scenario could "snowball" with incomplete combustion occurring, condensation in the vent, and corrosion.

For the same reasons, air returning for re-heating should never be pulled from the same space as the furnace combustion air supply. Installations where the furnace is centrally located, as in a hall closet, require the return air to be ducted to the furnace from a location outside of the closet. It is also a good idea, in such installations, to provide a method of bringing fresh, outside air directly to the furnace.

As a matter of fact, recent studies indicate it is always a good idea to supply fresh, outside air for combustion on any installation. There is a very good reason for this. Contaminated combustion air can cause serious corrosion problems within both the furnace and the vent system. Some states have now included the requirement for outside air in their state codes.

Elements such as chlorides and fluorides produce highly corrosive acids when burned and then condensed. If the water vapor in the flue products condenses with these elements in the combustion air, hydrochloric acid or hydrofluoric acid may be a result. These chlorides and fluorides can be found in abundance in any building. They can be found in bleaches, detergents, cleaning solutions, solvents, spray can propellants, cements, adhesives, and halogenated refrigerants. It is evident that it would be almost impossible to eliminate all of these contaminants from the atmosphere. Therefore, supplying fresh, outside combustion air should be considered for every installation.

Confined Spaces

The National Fuel Gas Code contains recommendations to supply outside air anytime the room containing the equipment falls under the heading of being a confined space. A confined space is a room whose volume is less than 50 cubic feet per 1000 BTUH of total input to all appliances installed in the room. For example, a room contains a gas water heater with 40,000 BTUH input and a furnace with 80,000 BTUH input for a total of 120,000 BTUH. At 50 cubic feet per 1000 BTU input, 6000 cubic feet (120 x 50) is required to preclude the space being classified as a confined space. If the equipment room was 12' x 20' x 8' (1920 cu. ft.) for instance, such a room would be considered a "confined space.

For the installation depicted in Figure 36 to be valid, the rooms on the other side of the openings must constitute a total volume which meets the requirements for an unconfined space. For instance, in the previous written example, the equipment room had a volume of 1920 cubic feet. The total input to the appliances within the room was 120,000 BTUH. 6,000 cubic feet or more of volume is needed to constitute an unconfined space. So, in Figure 36, the room connecting through the openings would have to make up the balance of the required 6,000 cubic feet.

$$6{,}000 - 1{,}920 = 4{,}080$$

4,080 cubic feet of free space would be needed the other side of the ventilation air openings. That might be a room with eight foot ceilings which measured 510 square feet. Also, this 510 square foot area cannot, by any means, be reduced. If, for example, a hall and adjacent room are being used for this 510 square feet then there cannot be any doors or curtains between them.

Figures 36, 37, 38, and 39 illustrate four acceptable methods

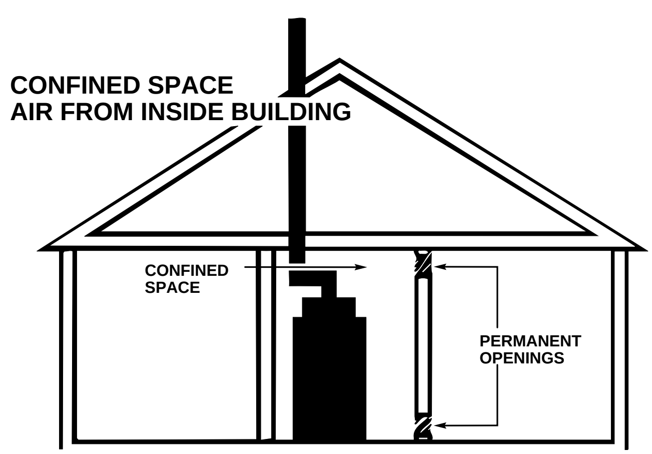


Figure 36

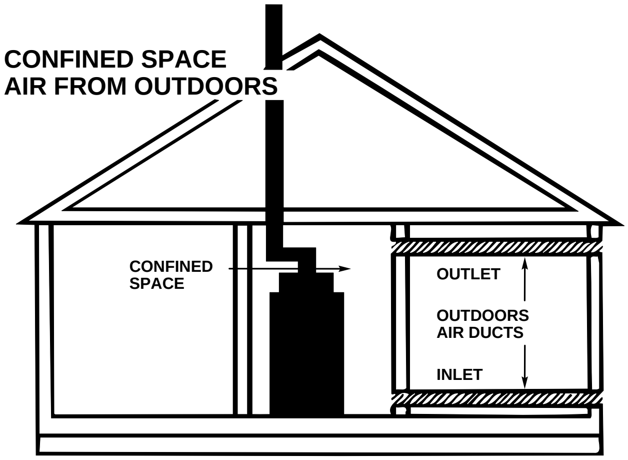


Figure 37

for supplying combustion and ventilation air to gas appliances located in a confined space. Of the two ventilating air openings shown in Figures 36 through 39, one opening should be located within 12 inches of the floor and the other within 12 inches of the ceiling. Even for short appliances, the space between the louvered openings should never be less than 3 1/2 feet. If connected with ducts, the cross-section area of the duct shall not be less than the free area of the louvered opening.

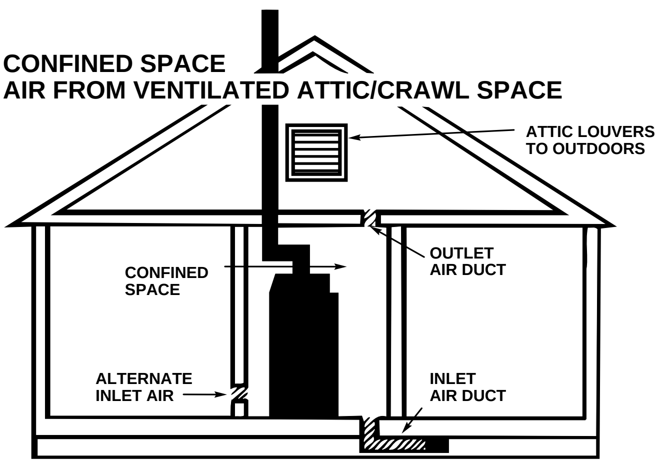


Figure 38

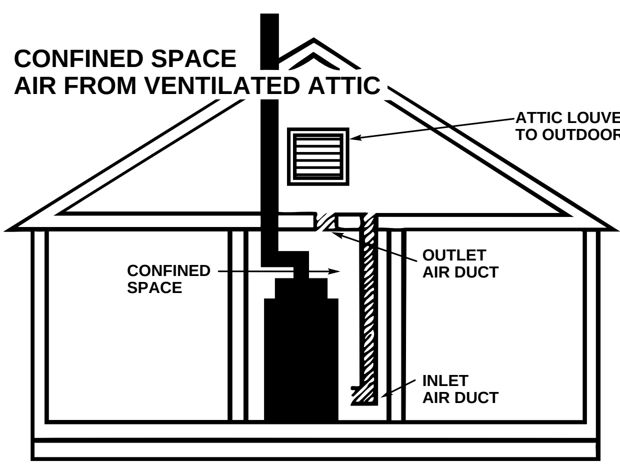


Figure 39

Unconfined Spaces

Unconfined spaces will normally have enough natural infiltration of air. If the construction is unusually tight, air from outdoors will be needed. The minimum dimension of rectangular air ducts shall be not less than 3 inches. Screening to cover the openings to the outside should not be smaller than 1/4 inch mesh and shall not be capable of closure. Insect screening and louvers reduce effective area.

In calculating the free area of air openings. consideration shall be given to the blocking effect of louvers and grilles. If the free area through a design of louver or grille is known. it should be used in calculating the size opening required to provide the free area specified. If the design and free area is not known, it may be assumed that wood louvers will have a 20 to 25 percent free area and metal louvers and grilles will have a 60 to 75 percent free area. Louvers and grilles shall be fixed in the open position or interlocked with the equipment so that they are opened automatically during equipment operation. Ref: **National Fuel Gas Code** Section 5.3.5. The return air, circulating for reheating by the furnace should be isolated from the air supply coming from the outside through these ducts.

General Installation

Specific instructions for installing vent systems are usually available through vent and furnace manufacturers. Also, national, state, and local codes cover many of the specifications such as vent type, vent materials, and installation practices. In all cases, the code authority having jurisdiction will have the final say over any installation. This section covers some general guidelines which have been "time" tested. There are also some additional procedures which have proved reliable in the field. Many of these additional measures have been adopted by some manufacturers and are included in their installation instructions.

Vent Fittings

Figure 40 depicts different fittings which are used in a vent system. The use of many of these fittings is self explanatory. It is recommended that Underwriter's Laboratories listed vents and fittings be used. Some of the fittings require a little explanation.

Roof flashing - The roof flashing should fit tightly over the hole in the roof. It should also mesh with the roof shingles. Notice there are two kinds of roof flashings illustrated.

Storm collar - The storm collar is a counter flashing for the roof flashing. Its purpose is to keep out snow and rain. The storm collar should fit tightly around the vent pipe and above the roof flashing. The area where the storm collar wraps around the vent pipe should be caulked with plastic cement or high temperature RTV silicone.

Firestops - A firestop assembly should be installed where the vent passes through a floor or ceiling. The purpose of the firestop is to close up the opening made to allow clearance for the vent pipe. This prevents a "chimney" effect from occurring through the opening in the event of a fire.

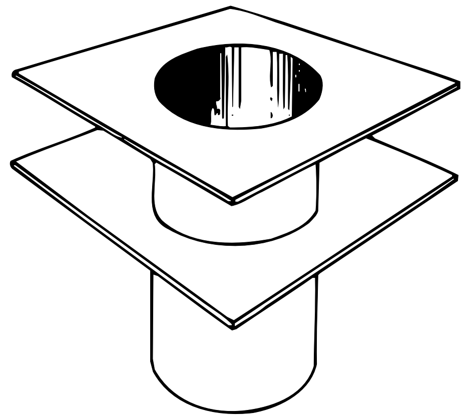
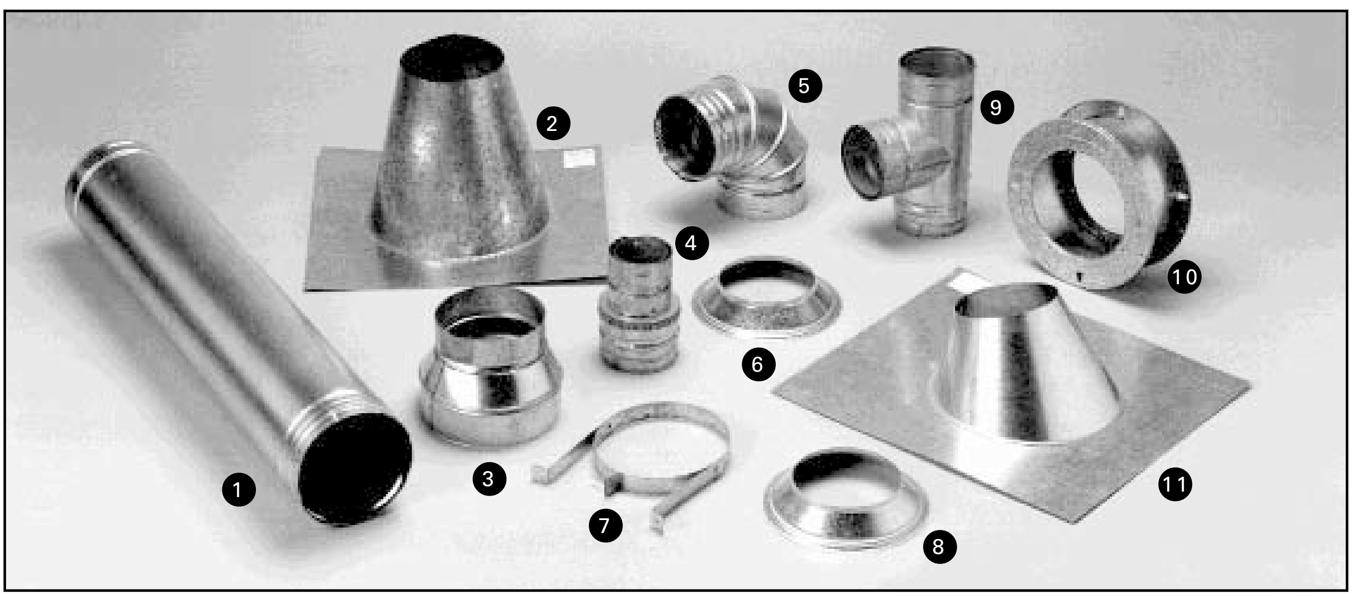


Figure 41

Figures 41 and 42 show a typical firestop and ceiling support. Either one can serve as a firestop. Either can also be used to center the pipe to allow specified clearance from combustibles. When installing a sheet metal firestop such as in Figure 41, the firestop should be attached to the joists



1. Round Pipe
2. Tall Cone Roof Flashing
3. Draft Hood Connector
4. Reducer
5. 90° Adjustable Elbow
6. Cover-All Face Plate
7. Wall Bracket
8. Storm Collar
9. Standard Tee
10. Wall Thimble
11. Adjustable Roof Flashing

Figure 40

and to framing cross members. This is to ensure that no spaces will exist which will allow the accumulation of combustible materials around the vent.

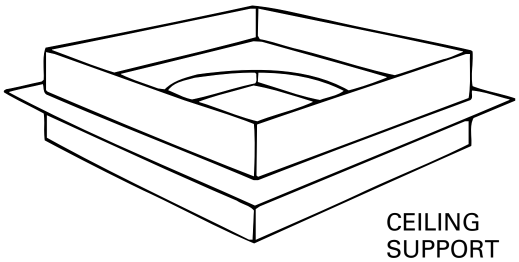
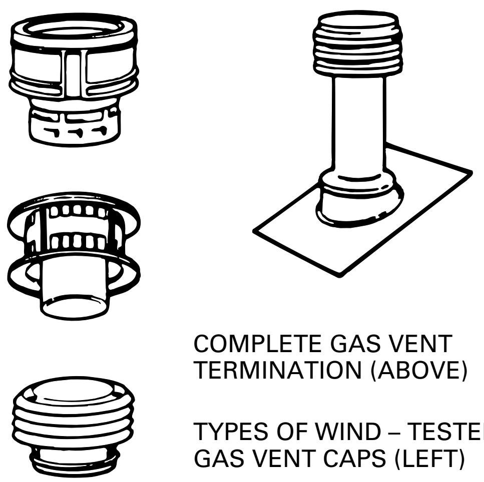


Figure 42

Joint Connections - All joints must be secure and leak tight. If a joint leaks, air may be pulled into the vent (in a natural draft vent) and further dilute the flue gases. The result would be a reduction in the draft force. Pipe with locking connections should be pressed together until it locks. Pipe without locking connections should be assembled with sheet metal screws and then sealed.

Vent Terminals - There are many different types of vent terminals, as illustrated in Figure 43. In general, the vent terminal (or vent cap) should be the same size as the vent to prevent restricting the vent. Also, some vent caps are designed primarily to keep rain and snow out of the vent. Others are designed to also baffle wind in order to prevent back drafts.



COMPLETE GAS VENT TERMINATION (ABOVE)

TYPES OF WIND – TESTED GAS VENT CAPS (LEFT)

Figure 43

Vent terminals should be located at least five feet above the furnace flue outlet or draft hood. Also, if the vent terminal extends five feet or more from the roof, then it should be braced or secured with guy wires.

Draft Hoods/Draft Diverter Connections - In most cases, the vent or vent connector will be the same size as the draft hood/diverter flue collar. The connector should be placed over the flue collar and attached with sheet metal screws. Flow arrows on the connector pipe should be pointing away from the furnace.

The design of a draft hood or draft diverter is the result of tested performance. It should not be altered in any way or assembled to the appliance in any way which does not comply with manufacturers' instructions. Vertical draft hoods should not be mounted horizontally and vice versa.

Support - Support of the vent system is required to keep joint connections intact. The furnace flue collar is not designed to provide support of vertical vents or vent connectors.

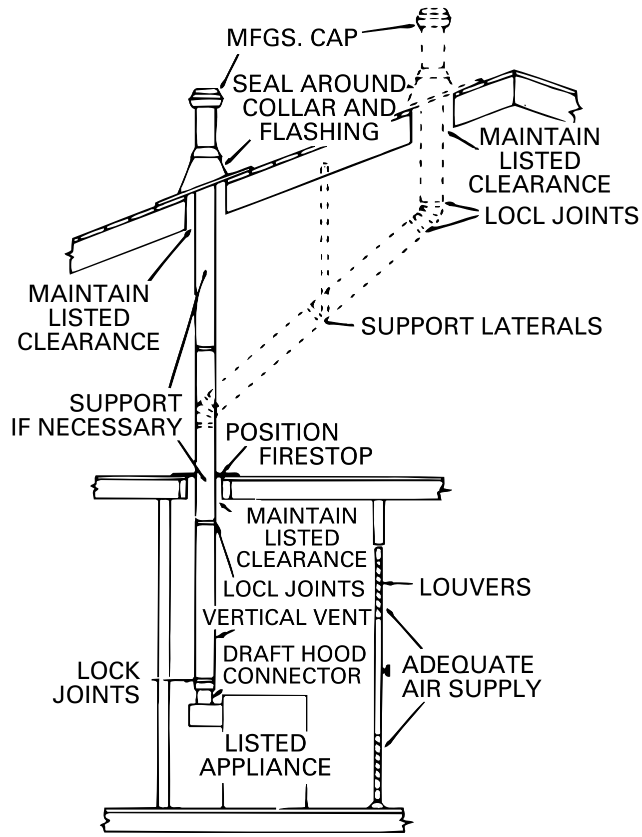


Figure 44

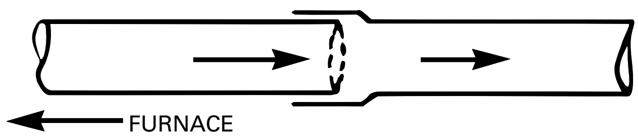
Figure 44 illustrates a well assembled vent system. Support lateral vent connectors as near the flue collar as possible and every three feet from there. Lateral supporting is usually accomplished with metal hanging straps. Vertical supporting can be done using the ceiling support which was shown in Figure 42.

Lateral runs - Lateral runs should be avoided, if possible. When lateral runs are necessary, the length should be kept as short as possible. Also, avoid an unnecessary number of turns and bends. Remember, each 90 degree elbow in excess of two causes a 10% reduction of the vent capacity. To explain it differently, each 90 degree elbow causes resistance equivalent to a lateral length of pipe 40 times the pipe diameter. A six inch elbow is the same as 240 inches or 20 feet of 6 inch pipe. The maximum length of lateral vent pipe can not exceed 75% of the total height of the vent. An upward pitch of at least 1/4 inch per lateral foot should be maintained.

Obstructions - Internal obstructions reduce the effective internal area of the vent and, therefore, reduce the capacity of the vent. Where vent connectors attach to a common vent or chimney, they should be installed flush with the inside surface at the point of entry. Accessories such as vent dampers also cause some restriction. The amount of restriction will depend on the design of the damper. Sometimes, foreign objects such as bird's nests, mice, ice, snow, etc. have been known to get into a vent and block it. The proper use of bird screens and vent caps will combat these "uninvited guests. "

Clearance Requirements – Vent pipe clearance from combustible materials must comply with national, state, and local codes. This clearance is usually six inches for single-wall vent pipe and one inch forType B double-wall vent pipe. These clearance requirements can be maintained by the use of straps, non-combustible spacers, wall thimbles, fire-stop spacers and ceiling supports.

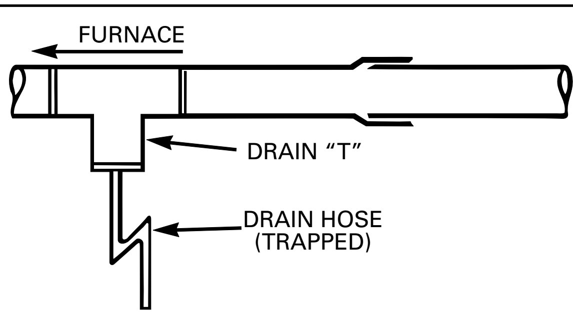
Plastic pipe vents, where allowed by code, are used for furnaces which have relatively cool flue-gas temperatures. Also, plastic pipe (PVC or CPVC) does not readily conduct heat. Because of these two facts plastic pipe vents, where allowed by code, can be installed with zero clearance. The special high temperature plastic pipe, used with 78 to 83% AFUE furnaces, has clearance requirements. See the installer's



Male ends away from furnace. (Low efficiency)
Figure 45

guide for the furnace you are installing.

Pipe Orientation – MostType B vent pipe will have flow arrows stamped or embossed on the side of the pipe. When venting lower efficiency (high flue gas temperatures) furnaces, the vent should be installed with the flow arrow pointing away from the furnace. When installed in this manner, the male end of the pipe will be pointing away from the furnace. See Figure 45. This allows the flue-gases to "slip" through the joint more easily.



Male ends toward furnace. (High efficiency)
Figure 46

When venting higher efficiency furnaces, the removal of condensate from the vent is an area of prime concern. Figure 46 shows a vent installed with the male ends pointing toward the furnace. Also shown is a drain "Tee" with trapped drain line. Installation with the male ends toward the furnace allows the condensate to run more freely down the vent and into the drain. Obviously, this installation will have a slight effect on the travel of the flue-products up the vent pipe. For this reason, and also to prevent condensate leaks, it is necessary to seal these joints.

In installations where condensation is likely to occur, it is a good practice to install vent pipe with the linear seams on top. Actually, it is a good idea for all installations. This

Eddy currents over the top of a structure.

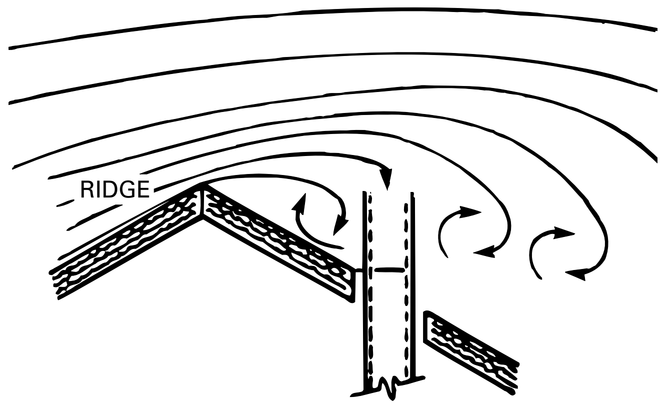


Figure 47

Positive pressure zone at exposed vertical wall.

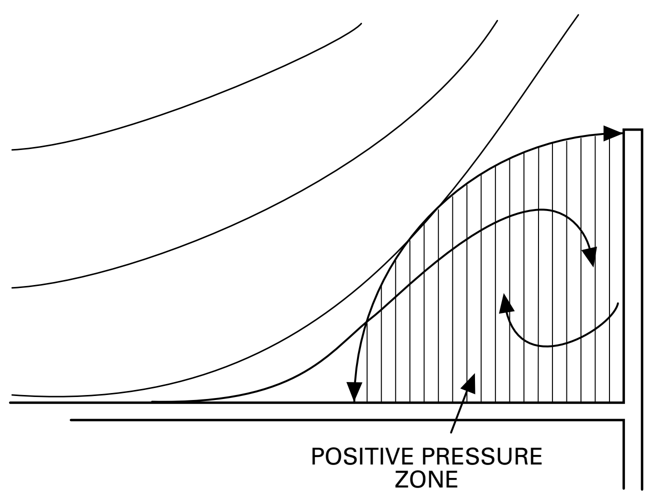


Figure 48

will also help to prevent leakage of any condensate which may form in the vent.

Terminal Location –The vent terminal, whether it is a masonry chimney or metal-pipe vent, should not be located where positive wind pressures occur. Positive pressure zones may be found due to eddy currents of air swirling over the top of a structure (Figure 47) or where a wall faces the prevailing winter wind (Figure 48). Vent termination in these areas can result in down-drafts. These down-drafts may cause flue gas spillage and/or pilot outages.

Wind tunnel tests have yielded guidelines for chimney and

Termination within 10 feet of a ridge, wall or parapet.

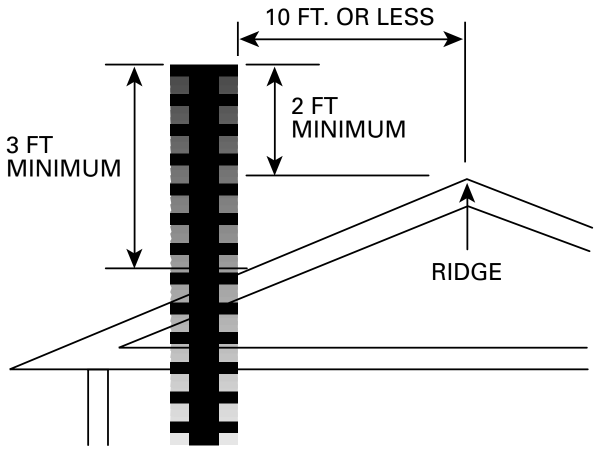


Figure 49

Termination 10 feet or more from ridge, wall or parapet.

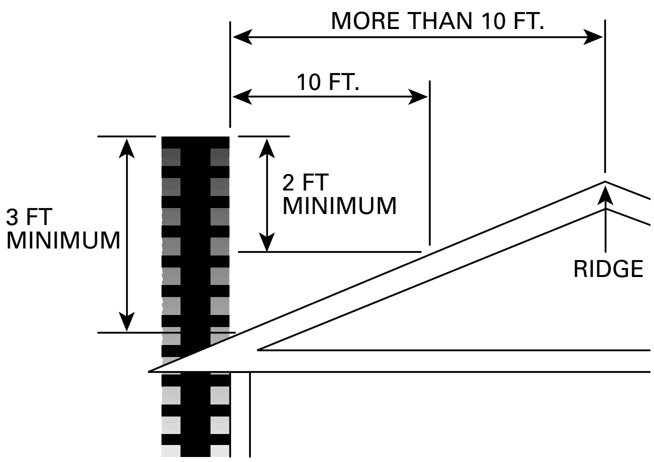


Figure 50

gas vent termination. Figure 49 depicts proper termination when the chimney or vent emerges through the roof within eight feet of a ridge, wall, or parapet. Figure 50 shows vent termination at a point eight or more feet away from obstructions.

Note: In both illustrations, showing 12" or less diameter terminations, the minimum height above the point where the vent comes through the roof is shown in the Gas Vent Termination Table. Fortunately, the one foot minimum height covers most requirements. (See Table)

As mentioned earlier, side-wall terminal locations for forced draft furnaces are found in the furnace manufacturers' installation instructions. The prime areas of concern for side-wall termination are dissipation of flue-gases, re-entry of flue-gases into the building, damage to surroundings, and furnace operation. Side-wall vents should not terminate through a wall, exposed to prevailing winter winds. Excessive vent pressures created may adversely affect furnace operation. Side-wall terminals should not be located in "dead corners" where the flue-products may accumulate. Care should be taken to avoid venting onto plants. The acidic nature of the flue-gases may be harmful to plants. Condensation which may form at the vent outlet can cause unsightly damage to the sides of the building. For this reason, manufacturers specify a minimum amount of vent pipe protruding from the wall. Some even recommend a corrosion resistant shield or flashing around the vent terminal.

Last, but in no way least, is safety. Vent terminals should be located high enough above pedestrian and vehicular paths to prevent the flue-gases exhausting on passers-by. Some manufacturers even prohibit installation above pedestrian walkways.

The manufacturers' installation instructions for side-wall termination should contain clearances from possible air entry points into the building. It is important that side-wall terminals be either above or at a safe lateral distance from doors, windows, etc. Figure 33 diagrams the clearances specified for venting through a wall.

Safeties and Accessories

Vent Safety Shut-off

On November 1, 1987, a national standard went into effect requiring a vent safety shut-off to be located in the draft hood or draft diverter of listed gas-fired equipment. The vent safety shut-off (sometimes referred to as a "spill" switch) is a thermal cut-out located in the draft hood/diverter. It will close the gas valve in the event of the flue-product spillage at the draft hood/diverter. In retro-fit applications, the shut-off should be located in a position where it will not affect the normal operation of the furnace. **It must be wired into the furnace controls so that the gas valve will not open unless the shut-off switch is in the closed position, (in series with the gas valve solenoid).**

Accurate vent sizing is critical to avoid nuisance tripping of the vent safety shut-off. A vent which is undersized or restricted will cause spillage at the draft hood/diverter, causing the shut-off to open. Over-sized vent systems are prone to excessive heat loss within the vent. This heat loss will cause the flue-gases to lose momentum. In this case, the flue-gases can "linger" in the area of the draft hood/diverter long enough to cause the shut-off to open. In grossly oversized vents, the heat loss can overcome the momentum of the flue-gases completely resulting in spillage. This is another reason why accurate sizing of vent systems can't be over emphasized.

Vent Dampers

The purpose of a vent damper is to reduce the cost of heating by closing off the vent during the furnace off-cycle. This helps the furnace heat exchanger to retain heat which would normally be lost through the vent. The amount of savings, if any, depends on the installation. Listed automatic vent dampers may be installed on an existing appliance if the appliance has a history of safe, satisfactory operation and it is equipped with a draft hood or draft diverter. Manually operated vent dampers shall not be installed in the vent connectors of a gas appliance. Electrically operated vent dampers must be connected to the furnace controls to prevent the firing of the main burners with the damper in the closed position.

Thermally operated automatic vent dampers require heat from the burners to activate them. It is obvious then that the control sequencing mentioned above cannot apply. Most thermal vent dampers are bi-metal vane designs which rely on the “warping” of the bi-metal to open. Until enough heat is applied to the thermal vent damper, the flue-products will have to go somewhere else. For this reason, automatic vent dampers can only be installed on gas appliances which have a draft hood or draft diverter. The relief opening in a draft hood/diverter provides a path for the flue-products in the event of a down-draft or flue blockage. If the equipment room is properly ventilated, then there should be no danger from the spillage which may occur.

Draft Inducers

When installing a power assisted draft inducer, it is always best to install it at the outlet of the vent. When installed in this manner, the flue-products will be “pulled” through the vent and discharged to the outside atmosphere. There is a margin of safety, so any leaks will cause ambient air to be drawn into the vent. If the draft inducer were to be installed at the inlet to the vent, positive vent pressures would mean that any leaks would be outward. Installation of a power assist at the vent inlet requires a sealed vent.

The draft inducer must be wired into the furnace controls so that the burners will not be fired unless it is operating. This is usually accomplished through the use of a normally open “sail” switch. The flow established by the draft-inducer will cause the contacts of the sail switch to close, proving the operation of the draft inducer. The sail switch would be wired in series with the room thermostat and gas valve or ignition controls.

Protection Against Fire Hazards

The proper installation of vents in accordance with manufacturers’ instruction is aimed at eliminating fire hazard conditions. Type B-W vent, which is used for venting recessed heaters, must be installed with a solid header plate to serve as a firestop. A **firestop spacer** is also to be placed at each point where the vent passes through a floor or ceiling.

Prohibited Installations

There are some installations that are prohibited by codes

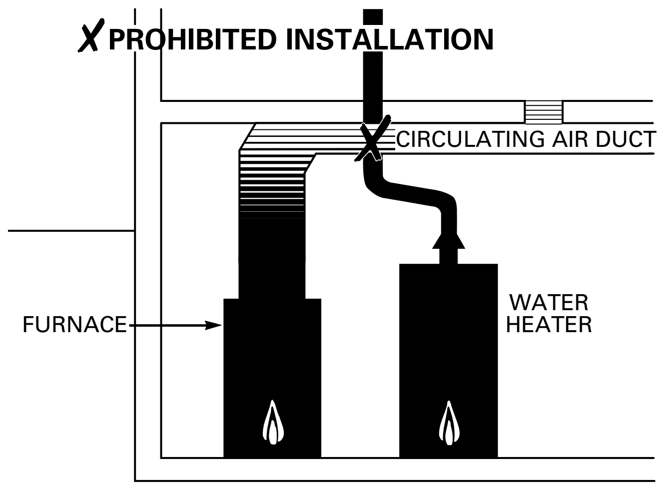


Figure 51

and local authorities. There are others which represent potentially unsafe situations. If it is possible to recognize these types of situations, serious problems may be avoided.

Single-walled pipe is not recommended for outside vents

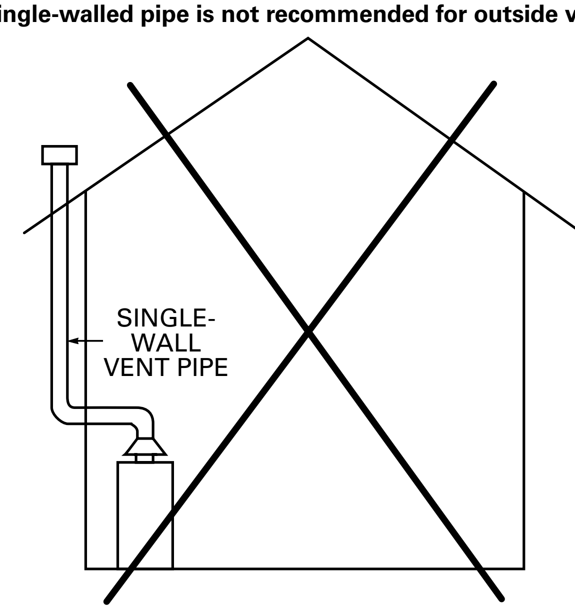


Figure 52

The National Fuel Gas Code suggests several installation practices to avoid. It should be consulted for description of these cases, but briefly they are as follows:

No portion of the venting system shall extend into or pass through any circulating air duct or plenum. By adhering to this practice, the chance of flue product leakage into circulating air streams will be minimized. See Figure 51.

The use of uninsulated single-wall pipe is not recommended for use outdoors in cold climates. Such use may cause condensation and corrosion of the vent system. See Figure 52.

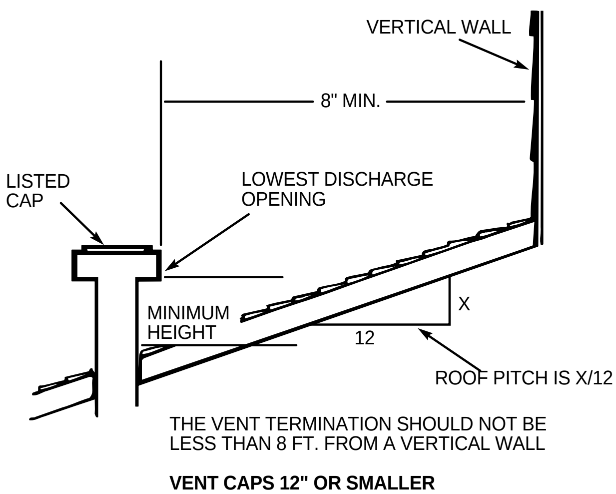


Figure 53

Wind flow over roof structures often causes localized pressure disturbances. The vent termination must be placed where these effects are minimized.

Termination of the vent must be at least 1 foot above the highest point where it passes through a roof on a flat to 7/12 pitch roof and at least 2 feet above the highest part of the roof within 8 feet, provided the termination is 12 inches in diameter or less. Except for direct vent appliances, the vent should not terminate adjacent to a wall or below eaves or parapets. See Figure 53.

The height of Type B vents must not be less than 5 feet in vertical height above the highest connected draft hood.

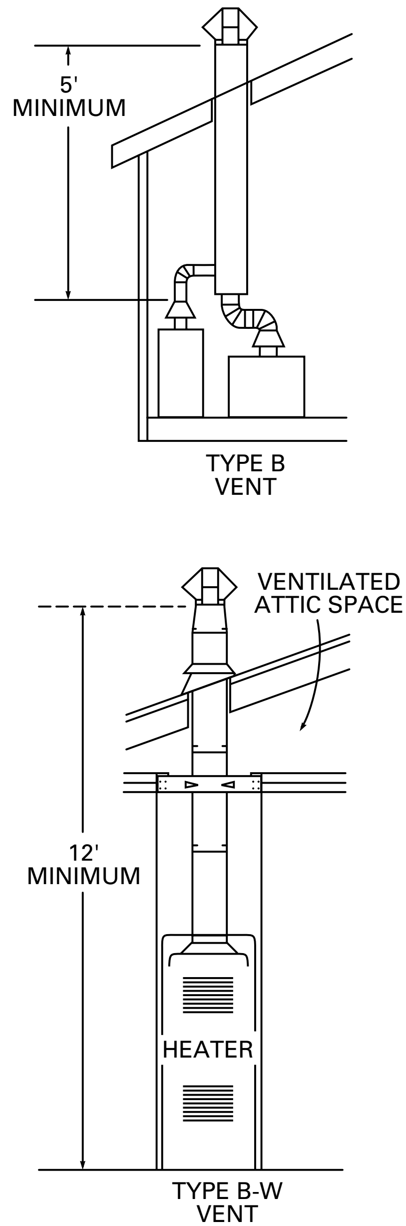


Figure 54

For Type B-W vents, the minimum height must be at least 12 feet, from the base of the heater. See Figure 54. If vents are less than these minimum heights, spillage may occur.

Do not exhaust a clothes dryer into a vent or chimney. The power exhaust system of the dryer often overloads the vent resulting in unsatisfactory operation of other appliances. The moisture-laden air is almost certain to result in condensation when the vent is cool. Furthermore, lint may accumulate causing blockage.

Troubleshooting

Problems with venting systems are not usually reported by the building's occupants unless they smell something. Sometimes a "no heat" complaint due to chronic pilot flame outages is a result of improper venting. It is important that installers and service technicians be observant and know the signs of poor vent performance.

Pilot Outage or Lock Out

More often than not, pilot outages are caused by malfunctions in the pilot system. Dirty pilot orifices or improper thermocouple/pilot-flame orientation are some causes for chronic pilot outages. Sometimes, however, pilot outage can be traced to the vent system. The first thing to look for is the vent cap. Make sure the cap is present and securely fastened to the vent. The cap should also be checked to see if the design will reduce the effects of wind. Sometimes, changing the vent cap to a more suitable wind-baffling design may solve the problem.

The problem could also be improper terminal location. If the terminal is located in a high pressure area, downdrafts may blow the pilot flame out. The solution would be to either relocate the vent terminal or to raise the vent height to get the terminal out of the positive pressure area. If the pilot outage problem is not very frequent, the downdrafts may not be very strong. Even in these cases, steps to prevent down-drafts should be taken. As a possible alternative in this situation, installation of some type of intermittent pilot ignition system might be considered.

Vent System Testing

When an existing furnace is removed from a venting system serving other appliances, the venting system is likely to be too large to properly vent the remaining attached appliances.

The following steps shall be followed with **each appliance** remaining connected to the common venting system placed in operation, while the other appliances remaining connected to the common system are in operation:

a. Seal any unused openings in the common venting system.

b. Visually inspect the venting system for proper size and horizontal pitch. Determine that there is no blockage or restriction, leakage, corrosion or other deficiencies which could cause an unsafe condition.

c. Insofar as it is practical, close all building doors and windows and all doors in between the space where the appliances remaining connected to the common vent system are located and the rest of the building. Turn on clothes dryers and any gas-burning appliances not connected to the common venting system. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close the fireplace dampers.

d. Follow the lighting instructions. Place the appliances in operation. Adjust the thermostat so the appliance will operate continuously.

e. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use the flame of a match or candle or smoke from a cigarette, cigar or pipe.

f. After it has been determined that each appliance remaining attached to the common venting system properly vents when tested as outlined, return doors, windows, exhaust fans, fireplace dampers and any other gas-burning appliance to their previous condition of use.

g. If improper venting is observed during any of the tests, the common venting system must be corrected according to the standards set forth in the National Fuel Gas Code, ANSI Z223.1.

Spillage

Spillage of flue-products from the draft hood/diverter is usually detected by an unpleasant odor. There are many reasons for spillage to occur. One cause might be an undersized vent. If the vent is too small, it will not have the physical capacity to move the volume of combustion products being produced. The solution is to replace the vent with a larger diameter vent. Another solution might be to increase the overall height of the vent. The section in this manual on **Factors Which Affect Vent Operation** pointed out why an increase in height increases the capacity of a vent. The capacity tables found in this manual and also in the **National Fuel Gas Code** can be used to determine the feasibility of this solution. If neither of the previously mentioned solutions are acceptable, then power venting should be considered.

On the other hand, oversized vents can also result in spillage. This is because the larger area results in a loss of velocity or momentum. The problem is compounded because the flue-gases are given more time to cool. They also have a greater mass of metal to surrender heat to. This cooling results in a reduction of the draft force. Increasing vent height will only aggravate this situation as the vent capacity is already too great. Two solutions to the problem of oversized vents are: install the correct size vent or install a draft inducer.

Another cause of spillage can be an undersized vent cap. Usually, if the vent itself is correctly sized, a vent cap the same size as the vent will perform satisfactorily. The solution is to insure that the vent cap is not highly restrictive and is at least the same size as the vent. Again, power venting is possible solution.

Spillage can also be caused by excessive resistance due to poor vent system design or installation. This excess resistance may be due to an excessive number of elbows, exceedingly long lateral runs, or improper pitch in lateral runs. The number of elbows in a vent system should be kept to a minimum. Vent capacity tables already take into account two elbows.

Each 90 degree elbow, in excess of two, decreases vent capacity by 10%. As a general rule, lateral length should be limited to 75% of the total vent height. This rule may not apply, however, to vent systems with several elbows.

Installations with several elbows and long horizontal runs will perform poorly. Proper slope must be maintained in lateral runs. The pitch should be at least 1/4 inch per lateral foot of run. In the extreme case, a downward pitched horizontal pipe may even form a trap, possibly resulting in spillage.

Resistance to flow in a vent may also come in the form of restrictions. These restrictions may be caused by the presence of foreign objects such as bird's nests, rodent nests, or insect nests, etc. Vents should be periodically inspected for the presence of obstructions. A screen on the vent outlet may be necessary.

Restrictions can also come in the form of accessories such as dampers, draft regulators or inoperative induced-draft blowers. Faulty accessories must be replaced. Control of these accessories must be integrated with the combustion system to prevent firing of the furnace in the event of a malfunction. Vent systems should be inspected for damaged or deformed pipe. A sizeable dent in a vent pipe may also be a restriction.

Flue-gas spillage may occur when the combustion and dilution air supplies are under negative pressures. If a structure contains other devices which exhaust air, close attention must be paid to the ventilation air supply. Range hoods, bath room and kitchen exhausts are examples of such devices. The air supply for a furnace should never come from the same immediate area where these appliances are located.

VENT TABLES

Capacity of Type B Double-Wall Vents with Type B Double-Wall Connectors
Serving a Single Category I Appliance

TABLE 1

		Vent and Connector Diameter - D (inches)																				
		3"			4"			5"			6"			7"			8"			9"		
		Appliance Input Rating in Thousands of Btu Per Hour																				
Height H (ft)	Lateral L (ft)	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max
6	0	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	897	470
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217	53	425	265	63	543	330
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	93	536	362
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205	93	413	273	110	530	354
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1006	537
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	60	619	418
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	99	607	407
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	117	596	396
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1096	585
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	57	684	457
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	95	671	446
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	122	651	427
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1263	682
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	53	815	544
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	90	800	529
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	116	777	507
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	134	755	491
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430	0	1057	575	0	1384	752
	2	10	75	51	14	149	100	18	250	165	20	377	249	33	531	346	41	711	470	50	917	612
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460	86	902	599
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443	112	877	576
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308	111	654	427	129	853	557
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295	125	634	410	145	830	537
30	0	0	100	64	0	213	128	0	374	220	0	587	335	0	853	475	0	1173	650	0	1548	855
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	42	1072	700
	5	21	77	54	28	160	108	36	275	176	43	421	273	58	600	385	69	811	524	82	1055	688
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	107	1028	668
	15	33	64	NR	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	124	1002	648
	20	56	58	NR	53	132	90	66	237	154	80	374	237	102	542	343	119	743	473	139	977	628
	30	NR	NR	NR	73	113	NR	88	214	NR	104	346	219	131	507	321	149	702	444	171	929	594
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518	0	1297	708	0	1730	952
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	33	1276	813
	5	20	82	NR	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	77	1259	798
	10	26	76	NR	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	101	1230	773
	15	59	70	NR	42	158	NR	54	287	180	66	455	288	85	662	413	100	911	572	117	1203	747
	20	NR	NR	NR	50	149	NR	63	275	169	76	440	278	97	642	401	113	888	556	131	1176	722
	30	NR	NR	NR	69	131	NR	84	250	NR	99	410	259	123	605	376	141	844	522	161	1125	670
100	0	NR	NR	NR	0	218	NR	0	407	NR	0	665	400	0	997	560	0	1411	770	0	1908	1040
	2	NR	NR	NR	10	194	NR	12	354	NR	13	566	375	18	831	510	21	1155	700	25	1536	935
	5	NR	NR	NR	26	189	NR	33	347	NR	40	557	369	52	820	504	60	1141	692	71	1519	926
	10	NR	NR	NR	33	182	NR	43	335	NR	53	542	361	68	801	493	80	1118	679	94	1492	910
	15	NR	NR	NR	40	174	NR	50	321	NR	62	525	353	80	782	482	93	1095	666	109	1465	895
	20	NR	NR	NR	47	166	NR	59	311	NR	71	513	344	90	763	471	105	1073	653	122	1438	880
	30	NR	NR	NR	NR	NR	NR	78	290	NR	92	483	NR	115	726	449	131	1029	627	149	1387	849
	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	147	428	NR	180	651	405	197	944	575	217	1288	787

VENT TABLES

Capacity of Type B Double-Wall Vents with Type B Double-Wall Connectors
Serving a Single Category I Appliance

TABLE 1 (Cont'd)

Vent and Connector Diameter - D (inches)

Appliance Input Rating in Thousands of Btu Per Hour

Height H (ft)	Lateral L (ft)	10" FAN Min	10" FAN Max	10" NAT Max	12" FAN Min	12" FAN Max	12" NAT Max	14" FAN Min	14" FAN Max	14" NAT Max	16" FAN Min	16" FAN Max	16" NAT Max	18" FAN Min	18" FAN Max	18" NAT Max	20" FAN Min	20" FAN Max	20" NAT Max	22" FAN Min	22" FAN Max	22" NAT Max	24" FAN Min	24" FAN Max	24" NAT Max
6	0	0	1121	570	0	1645	850	0	2267	1170	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	75	675	455	103	982	650	138	1346	890	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	110	668	445	147	975	640	191	1338	880	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	128	661	435	171	967	630	219	1330	870	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	1261	660	0	1858	970	0	2571	1320	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4015
	2	71	770	515	98	1124	745	130	1543	1020	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	115	758	503	154	1110	733	199	1528	1010	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	137	746	490	180	1097	720	231	1514	1000	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	1377	720	0	2036	1060	0	2825	1450	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	66	831	560	91	1244	850	124	1713	1130	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	112	803	547	149	1229	829	191	1696	1105	243	2238	1461	300	2849	1871	362	3536	2318	458	4301	2818	540	5132	3371
	10	142	787	525	187	1204	795	238	1669	1080	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	1596	840	0	2380	1240	0	3323	1720	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10393	5300
	2	61	1016	675	86	1495	985	114	2062	1350	147	2719	1770	186	3467	2260	230	4304	2800	290	5232	3410	346	6251	4080
	5	105	1000	660	140	1476	967	182	2041	1327	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	135	977	635	177	1446	936	227	2009	1289	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
	15	155	953	610	202	1418	905	257	1976	1250	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980
20	0	0	1756	930	0	2637	1350	0	3701	1900	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11753	6000
	2	56	1150	755	81	1694	1100	107	2343	1520	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	101	1133	738	135	1674	1079	174	2320	1498	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	130	1105	710	172	1641	1045	220	2282	1460	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
	15	150	1078	688	195	1609	1018	248	2245	1425	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575
	20	167	1052	665	217	1578	990	273	2210	1390	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550
30	0	0	1977	1060	0	3004	1550	0	4252	2170	0	5725	2920	0	7420	3770	0	9341	4750	0	11483	5850	0	13848	7060
	2	54	1351	865	74	2004	1310	98	2786	1800	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	295	8617	5600
	5	96	1332	851	127	1981	1289	164	2759	1775	206	3666	2350	251	4701	3020	312	5861	3783	373	7155	4622	439	8574	5552
	10	125	1301	825	164	1944	1254	209	2716	1733	259	3617	2300	316	4647	2970	386	5801	3739	456	7090	4574	535	8505	5471
	15	143	1272	807	187	1907	1220	237	2674	1692	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391
	20	160	1243	784	207	1871	1185	260	2633	1650	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310
	30	195	1189	745	246	1796	1115	305	2551	1585	369	3433	2155	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225
50	0	0	2211	1195	0	3441	1825	0	4934	2550	0	6711	3440	0	8774	4460	0	11129	5635	0	13787	6940	0	16494	8437
	2	41	1620	1010	66	2431	1513	96	3409	2125	115	4554	2840	142	5864	3670	177	7739	4630	200	8980	5695	251	10768	6860
	5	90	1600	996	116	2406	1495	151	3380	2102	191	4520	2813	234	5826	3639	291	7695	4597	336	8933	5654	394	10717	6818
	10	118	1567	972	154	2366	1466	196	3332	2064	243	4464	2767	295	5763	3585	355	7624	4542	419	8855	5585	491	10652	6749
	15	136	1536	948	177	2327	1437	222	3285	2026	274	4409	2721	330	5701	3534	396	7555	4511	465	8779	5546	546	10570	6710
	20	151	1505	924	195	2288	1408	244	3239	1987	300	4356	2675	361	5641	3481	432	7486	4479	506	8704	5506	586	10488	6670
	30	183	1446	876	232	2214	1349	287	3150	1910	347	4253	2631	411	5523	3431	494	7353	4421	577	8557	5444	672	10328	6603
100	0	0	2491	1310	0	3925	2050	0	5729	2950	0	7914	4050	0	10485	5300	0	13454	6700	0	16817	8600	0	20578	10300
	2	30	1975	1170	44	3027	1820	72	4313	2550	95	5834	3500	123	7591	4600	138	9577	5800	169	11803	7200	204	14264	8800
	5	82	1955	1159	107	3002	1803	136	4282	2531	172	5797	3475	201	7548	4566	245	9528	5768	293	11748	7162	341	14204	8756
	10	108	1923	1142	142	2961	1775	180	4231	2500	223	5737	3434	268	7478	4509	318	9447	5712	374	11658	7100	436	14105	8683
	15	126	1892	1124	163	2920	1747	208	4182	2469	257	5678	3392	304	7409	4451	358	9367	5665	418	11569	7037	487	14007	8610
	20	141	1861	1107	181	2880	1719	226	4133	2438	277	5619	3351	330	7341	4394	387	9289	5613	452	11482	6975	523	13910	8537
	30	170	1802	1071	215	2803	1663	263	4037	2375	319	5505	3267	378	7209	4279	446	9136	5509	514	11310	6850	592	13720	8391
	50	241	1656	1000	291	2657	1550	330	3856	2250	415	5289	3100	486	6956	4050	572	8841	5300	659	10979	6600	751	13354	8100

VENT TABLES

Capacity of Type B Double-Wall Vent with Single-Wall Connectors
Serving Two or more Category I Appliances

TABLE 4

Vent Connector Capacity

Vent Height H (ft)	Connector Rise R (ft)	3" FAN Min	3" FAN Max	3" NAT Max	4" FAN Min	4" FAN Max	4" NAT Max	5" FAN Min	5" FAN Max	5" NAT Max	6" FAN Min	6" FAN Max	6" NAT Max	7" FAN Min	7" FAN Max	7" NAT Max	8" FAN Min	8" FAN Max	8" NAT Max	9" FAN Min	9" FAN Max	9" NAT Max	10" FAN Min	10" FAN Max	10" NAT Max
6	1	NR	NR	26	NR	NR	46	NR	NR	71	NR	NR	102	207	223	140	262	293	183	325	373	234	447	463	286
	2	NR	NR	31	NR	NR	55	NR	NR	85	168	182	123	215	251	167	271	331	219	334	422	281	458	524	344
	3	NR	NR	34	NR	NR	62	121	131	95	174	193	138	222	273	188	279	361	247	344	462	316	468	574	385
15	1	NR	NR	29	79	87	52	116	138	81	177	214	116	238	291	158	312	380	208	397	482	266	556	596	324
	2	NR	NR	34	83	94	62	121	150	97	185	230	138	246	314	189	321	411	248	407	522	317	568	646	387
	3	NR	NR	39	87	100	70	127	160	109	193	243	157	255	339	215	331	438	281	418	557	360	579	690	437
30	1	47	60	31	77	110	57	113	175	89	169	278	129	226	369	175	296	497	230	378	630	294	528	779	358
	2	50	62	37	81	115	67	117	185	106	177	290	152	236	390	208	307	521	274	389	662	349	541	819	425
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235	316	543	309	400	690	394	555	855	482
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188	284	604	245	364	768	314	507	951	384
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223	294	623	293	376	793	375	520	983	458
	3	53	72	45	83	136	82	119	221	128	178	353	186	235	486	252	304	640	331	387	816	424	535	1013	518

Vent Connector Diameter - D (inches); Appliance Input Rating Limits in Thousands of Btu Per Hour

Common Vent Capacity

Vent Height H (ft)	4" FAN +FAN	4" FAN +NAT	4" NAT +NAT	5" FAN +FAN	5" FAN +NAT	5" NAT +NAT	6" FAN +FAN	6" FAN +NAT	6" NAT +NAT	7" FAN +FAN	7" FAN +NAT	7" NAT +NAT	8" FAN +FAN	8" FAN +NAT	8" NAT +NAT	9" FAN +FAN	9" FAN +NAT	9" NAT +NAT	10" FAN +FAN	10" FAN +NAT	10" NAT +NAT
6	85	78	64	136	113	100	200	158	144	304	244	196	398	310	257	541	429	332	665	515	407
8	98	87	71	151	126	112	225	173	159	331	269	228	436	342	285	592	473	373	730	569	460
10	106	94	76	163	137	120	237	189	174	357	292	236	467	369	309	638	512	398	787	617	487
15	121	108	88	189	159	140	275	221	200	416	343	274	544	434	357	751	599	456	905	718	553
20	131	118	98	208	177	155	305	247	223	463	383	302	606	487	395	824	673	512	1013	808	626
30	145	132	113	236	202	179	350	286	257	533	446	349	703	570	459	958	790	593	1183	952	723
50	159	145	128	268	233	204	406	337	296	622	529	410	833	686	535	1139	954	689	1418	1157	838

Common Vent Diameter - D (inches); Combined Appliance Input Rating in Thousands of Btu Per Hour

VENT TABLES

TABLE 6

Capacity of Masonry Chimney with Single Wall Vent Connectors
Serving a Single Category I Appliance

Connector Diameter - D (inches)
To be used with chimney areas within the size limits at bottom

Appliance Input Rating in Thousands of Btu Per Hour

Height H (ft)	Lateral L (ft)	3" FAN Min	3" FAN Max	3" NAT Max	4" FAN Min	4" FAN Max	4" NAT Max	5" FAN Min	5" FAN Max	5" NAT Max	6" FAN Min	6" FAN Max	6" NAT Max	7" FAN Min	7" FAN Max	7" NAT Max	8" FAN Min	8" FAN Max	8" NAT Max	9" FAN Min	9" FAN Max	9" NAT Max	10" FAN Min	10" FAN Max	10" NAT Max	12" FAN Min	12" FAN Max	12" NAT Max
6	2	NR	NR	28	NR	NR	52	NR	NR	86	NR	NR	130	NR	NR	180	NR	NR	247	NR	NR	319	NR	NR	400	NR	NR	580
	5	NR	NR	25*	NR	NR	48	NR	NR	81	NR	NR	116	NR	NR	164	NR	NR	230	NR	NR	297	NR	NR	375	NR	NR	560
10	2	NR	NR	31	NR	NR	61	NR	NR	102	NR	NR	161	NR	NR	220	NR	NR	297	NR	NR	387	NR	NR	490	NR	NR	722
	5	NR	NR	28*	NR	NR	56	NR	NR	95	NR	NR	147	NR	NR	203	NR	NR	276	NR	NR	364	NR	NR	465	NR	NR	710
	10	NR	NR	24*	NR	NR	49*	NR	NR	86	NR	NR	137	NR	NR	189	NR	NR	261	NR	NR	345	NR	NR	441	NR	NR	665
15	2	NR	NR	35*	NR	NR	67	NR	NR	113	NR	NR	178	NR	NR	249	NR	NR	335	NR	NR	440	NR	NR	560	NR	NR	840
	5	NR	NR	32*	NR	NR	61	NR	NR	106	NR	NR	163	NR	NR	230	NR	NR	312	NR	NR	414	NR	NR	531	NR	NR	825
	10	NR	NR	27*	NR	NR	54*	NR	NR	96	NR	NR	151	NR	NR	214	NR	NR	294	NR	NR	392	NR	NR	504	NR	NR	774
	15	NR	NR	NR	NR	NR	46*	NR	NR	87*	NR	NR	138	NR	NR	198	NR	NR	278	NR	NR	372	NR	NR	481	NR	NR	738
20	2	NR	NR	38*	NR	NR	73	NR	NR	123	NR	NR	200	NR	NR	273	NR	NR	374	NR	NR	490	NR	NR	625	NR	NR	950
	5	NR	NR	35*	NR	NR	67*	NR	NR	115	NR	NR	183	NR	NR	252	NR	NR	348	NR	NR	461	NR	NR	594	NR	NR	930
	10	NR	NR	NR	NR	NR	59*	NR	NR	105*	NR	NR	170	NR	NR	235	NR	NR	330	NR	NR	437	NR	NR	562	NR	NR	875
	15	NR	NR	NR	NR	NR	NR	NR	NR	95*	NR	NR	156	NR	NR	217	NR	NR	311	NR	NR	414	NR	NR	536	NR	NR	835
	20	NR	NR	NR	NR	NR	NR	NR	NR	89*	NR	NR	144*	NR	NR	202	NR	NR	292	NR	NR	392	NR	NR	510	NR	NR	800
30	2	NR	NR	41*	NR	NR	81*	NR	NR	136	NR	NR	215	NR	NR	302	NR	NR	420	NR	NR	556	NR	NR	715	NR	NR	1110
	5	NR	NR	NR	NR	NR	75*	NR	NR	127*	NR	NR	196	NR	NR	279	NR	NR	391	NR	NR	524	NR	NR	680	NR	NR	1090
	10	NR	NR	NR	NR	NR	66*	NR	NR	113*	NR	NR	182*	NR	NR	260	NR	NR	370	NR	NR	496	NR	NR	644	NR	NR	1020
	15	NR	NR	NR	NR	NR	NR	NR	NR	105*	NR	NR	168*	NR	NR	240*	NR	NR	349	NR	NR	471	NR	NR	615	NR	NR	975
	20	NR	NR	NR	NR	NR	NR	NR	NR	88*	NR	NR	155*	NR	NR	223*	NR	NR	327	NR	NR	445	NR	NR	585	NR	NR	932
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	182*	NR	NR	281*	NR	NR	408	NR	NR	544	NR	NR	865
50	2	NR	NR	NR	NR	NR	93*	NR	NR	160*	NR	NR	250*	NR	NR	350*	NR	NR	475	NR	NR	631	NR	NR	810	NR	NR	1240
	5	NR	NR	NR	NR	NR	NR	NR	NR	149*	NR	NR	228*	NR	NR	321*	NR	NR	442	NR	NR	593	NR	NR	770	NR	NR	1220
	10	NR	NR	NR	NR	NR	NR	NR	NR	136*	NR	NR	212*	NR	NR	301*	NR	NR	420*	NR	NR	562	NR	NR	728	NR	NR	1140
	15	NR	NR	NR	NR	NR	NR	NR	NR	124*	NR	NR	195*	NR	NR	278*	NR	NR	395*	NR	NR	533*	NR	NR	695	NR	NR	1090
	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	180*	NR	NR	258*	NR	NR	370*	NR	NR	504*	NR	NR	660*	NR	NR	1040
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	318*	NR	NR	453*	NR	NR	610*	NR	NR	970
Minimum Internal Area of Chimney Square Inches		12			19			28			38			50			63			78			95			132		
Maximum Internal Area of Chimney Square Inches		49			88			137			198			269			352			445			550			792		

Note 27 – Numbers followed by an asterisk (*) indicate the possibility of continuous condensation, depending on locality. Consult appliance manufacturer, [local] serving gas supplier, and/or authority having jurisdiction.

TABLE 8

Capacity of Masonry Chimney with Single-Wall Connectors
Serving two or more Category I Appliances

Vent Connector Capacity

Vent Height H (ft)	Connector Rise R (ft)	3" FAN Min	3" FAN Max	3" NAT Max	4" FAN Min	4" FAN Max	4" NAT Max	5" FAN Min	5" FAN Max	5" NAT Max	6" FAN Min	6" FAN Max	6" NAT Max	7" FAN Min	7" FAN Max	7" NAT Max	8" FAN Min	8" FAN Max	8" NAT Max	9" FAN Min	9" FAN Max	9" NAT Max	10" FAN Min	10" FAN Max	10" NAT Max
6	1	NR	NR	21	NR	NR	39	NR	52	66	179	191	100	231	271	140	292	366	188	362	478	232	499	594	283
	2	NR	NR	28	NR	NR	52	NR	NR	64	186	221	128	236	321	172	301	432	224	371	557	289	509	666	351
	3	NR	NR	34	NR	NR	61	156	151	97	193	231	142	241	365	200	309	491	260	387	634	348	519	793	375
15	1	NR	52	21	47	53	45	129	151	73	199	271	112	258	376	170	349	502	225	445	649	281	622	831	365
	2	NR	NR	39	92	100	54	132	170	88	201	311	132	271	411	189	351	548	256	456	764	334	634	884	402
	3	NR	NR	34	96	117	61	141	192	101	212	315	153	288	433	219	366	586	287	465	755	378	646	915	417
12	1	NR	NR	24	46	108	47	136	167	80	191	147	134	279	492	183	338	665	250	419	866	390	496	1284	475
	2	NR	NR	31	91	119	51	137	200	95	201	264	142	288	516	205	346	694	282	442	908	372	613	1115	482
	3	NR	NR	35	98	123	65	114	216	105	208	191	160	277	543	230	358	739	315	452	945	432	635	1135	531
20	1	NR	NR	23	31	113	48	124	204	80	188	392	220	283	467	144	328	778	263	417	1022	355	443	1503	417
	2	NR	NR	33	35	122	57	110	210	84	144	430	189	282	546	188	337	806	304	429	1058	393	594	1546	542
	3	NR	NR	38	44	131	65	126	221	105	225	433	167	271	567	245	348	851	338	443	1090	451	621	1591	595

Vent Connector Diameter - D (inches); Appliance Input Rating Limits in Thousands of Btu Per Hour

Common Vent Capacity

Vent Height H (ft)	12 FAN +FAN	12 FAN +NAT	12 NAT +NAT	19 FAN +FAN	19 FAN +NAT	19 NAT +NAT	28 FAN +FAN	28 FAN +NAT	28 NAT +NAT	38 FAN +FAN	38 FAN +NAT	38 NAT +NAT	50 FAN +FAN	50 FAN +NAT	50 NAT +NAT	63 FAN +FAN	63 FAN +NAT	63 NAT +NAT	78 FAN +FAN	78 FAN +NAT	78 NAT +NAT	113 FAN +FAN	113 FAN +NAT	113 NAT +NAT
6	NR	74	25	NR	118	45	NR	176	71	NR	225	102	NR	348	143	NR	455	187	NR	579	245	NR	846	338
8	NR	79	28	NR	128	52	NR	190	83	NR	276	118	NR	380	163	NR	497	217	NR	633	277	NR	928	400
10	NR	83	31	NR	136	56	NR	203	90	NR	295	129	NR	405	177	NR	532	234	NR	680	300	NR	1000	435
15	NR	94	34	NR	157	64	NR	230	105	NR	335	150	NR	460	200	NR	602	280	NR	772	360	NR	1139	504
20	NR	90	48	NR	171	76	NR	247	123	NR	362	178	NR	502	250	NR	661	321	NR	849	415	NR	1264	588
30	NR	NR	NR	NR	NR	NR	NR	266	155	NR	398	205	NR	554	285	NR	729	372	NR	937	490	NR	1411	742
50	NR	NR	NR	NR	NR	NR	NR	305	NR	NR	NR	NR	NR	612	325	NR	821	456	NR	1076	600	NR	1611	910

Minimum Internal Area of Chimney, Square Inches; Combined Appliance Input Rating in Thousands of Btu Per Hour

TABLE 9

MASONRY CHIMNEY LINER DIMENSIONS
WITH CIRCULAR EQUIVALENTS

NOMINAL LINER SIZE INCHES	INSIDE DIMENSIONS IN LINER INCHES	INSIDE DIA. OR EQUIVALENT DIA. INCHES	EQUIVALENT AREA SQ INCHES
4 x 8	2 1/2 x 6 1/2	4	12.2
		5	19.6
		6	28.3
		7	38.3
8 x 8	6 3/4 x 6 3/4	7.4	42.7
		8	50.3
8 x 12	6 1/2 x 10 1/2	9	63.6
		10	78.5
12 x 12	9 3/4 x 9 3/4	10.4	83.3
		11	95
12 x 16	9 1/2 x 13 1/2	11.8	107.5
		12	113
		14	153.9
16 x 16	13 1/4 x 13 1/4	14.5	162.9
		15	176.7
16 x 20	13 x 17	15.2	206.1
		18	254.4
20 x 20	16 3/4 x 16 3/4	18.2	260.2
		20	314.1
20 x 24	16 1/2 x 20 1/2	20.1	314.2
		22	380.1
24 x 24	20 1/4 x 20 1/4	22.1	380.1
		24	452.3
24 x 28	20 1/2 x 24 1/4	24.1	456.2
28 x 28	24 1/4 x 24 1/4	26.4	543.3
		27	572.5
30 x 30	25 1/2 x 25 1/2	27.9	607
		30	706.8
30 x 36	25 1/2 x 31 1/2	30.9	749.9
		33	855.3
36 x 36	31 1/2 x 31 1/2	34.4	929.4
		36	1017.9

When liner sizes differ dimensionally from those shown in Table 9 equivalent diameters may be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

Glossary

AFUE – The Annual Fuel Utilization Efficiency (AFUE) is a ratio of annual output of useful energy delivered to the heated space to the annual fuel energy input.

ATMOSPHERIC PRESSURE – The pressure exerted on the earth's surface by the weight of the atmosphere above it. At sea level this is approximately 14.7 pounds per square inch, 760 mm of mercury.

BAFFLE – An object placed in appliance to change the direction of, or retard, the flow of air, air-gas mixtures, or flue gases.

CHIMNEY – *(Also see Gas Vents)* A vertical shaft enclosing one or more flues for conveying flue gases to the outside atmosphere.

a. Factory-Built Chimney. A listed chimney.
b. Masonry Chimney. A chimney of solid masonry units, bricks, stones, listed masonry units or reinforced concrete, lined with suitable flue liners.
c. Metal Chimney. A field-constructed chimney of metal.

CHIMNEY FLUE – *(See Flue)*

COMBUSTIBLE MATERIAL – As pertaining to materials adjacent to or in contact with heat producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts, shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that will ignite and burn. Such material shall be considered combustible even though flame-proofed, fire retardant treated, or plastered.

COMBUSTION – Rapid oxidation of fuel gases accompanied by the production of heat, or heat and light. Complete combustion of a fuel is possible only in the presence of an adequate supply of oxygen.

COMBUSTION AIR – Air supplied to an appliance specifically for the combustion of fuel.

COMBUSTION PRODUCTS – Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inerts but excluding excess air.

COMMON VENT – The portion of a vent system into which the flue gases from two or more appliances flow.

CONDENSATE (CONDENSATION) – The liquid which separates from a gas (including flue gas) due to a reduction in temperature.

CUBIC FOOT (Cu. Ft.) OF GAS – The amount of gas which would occupy 1 cubic foot when at a temperature of 60°F, saturated with water vapor, and under a pressure equivalent to that of 14.73 pounds per square inch absolute.

DENSITY – The weight of a substance per unit volume. As applied to gases, the weight in pounds of a cubic foot of gas at standard pressure and temperature.

DEW POINT – The temperature at which a vapor starts to condense into a liquid. In undiluted flue gases it is about 140°F. In diluted gases in the vent it is approximately 100 to 105°F.

DILUTION AIR – Air which enters a draft hood or draft regulator mixes with the flue gases.

DOWNDRAFT – A flow of air downward in the stack caused by excessively high air pressures created at the outlet of the chimney or vent cap or by negative pressure at the inlet of the vent system.

DRAFT HOOD/DRAFT DIVERTER – A device built into an appliance, or made a part of the flue or vent connector from an appliance, which is designed to (1) provide for the ready escape of the flue gases in the event of no draft, back draft, or stoppage beyond the draft hood; (2) prevent a back draft from entering the appliance; and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance.

DRAFT HOOD CONNECTOR – A transition fitting for connecting double-wall pipe to the single-wall flue collar or draft hood outlet of the appliance.

DRAFT REGULATOR – A device which functions to maintain a desired draft in the appliance by automatically reducing the draft to the desired value.

EXCESS AIR – Air which passes though the combustion chamber and the appliance flues in excess of that which is theoretically required for complete combustion.

FIRESTOP – A blockage placed in a hollow wall or opening in any other part of a building structure to halt upward progress of fire through the wall or opening.

FIRESTOP SPACER – A component of a vent system which serves to secure a vertical vent and at the same time serve as a firestop for the opening made for the vent through a floor, ceiling or wall.

FLUE – The general term for the passageways in an appliance and vents through which combustion products pass to the outside atmosphere.

1. Appliance Flue – The flue passageways within an appliance.
2. Chimney Flue – The vertical conduit for conveying combustion products delivered to it by a vent connector to the outside atmosphere.

FLUECOLLAR – That portion of an appliance designed for the attachment of the draft hood or vent connector.

FLUE EXHAUSTER – A device installed in and made a part of the vent which will provide a positive induced draft. *(Draft Inducer)*

FLUE GASES – Products of combustion plus excess air in appliance flues or heat exchangers (before the draft hood or draft regulator. *(See Vent Gases).*

FLUE OUTLET – The opening provided in an appliance for the escape of the flue gases.

FLUE PRODUCTS – *(See Flue Gases)*

GAS VENTS – Factory-built vent piping and vent fittings listed by a nationally recognized testing agency, that are assembled and used in accordance with the terms of their listings, for conveying flue gases to the outside atmosphere.

a. Type B Gas Vent. A gas vent for venting gas appliances with draft hoods and other gas appliances listed for use with Type B Gas Vents.

b. Type B-W Gas Vent. A gas vent for venting listed gas-fired vented wall furnaces.

c. Type L Venting System. A venting system composed of listed factory-built components assembled in accordance with the terms of listing for venting appliances listed for use with Type L venting systems. They may be used also where Type B gas vents are permitted.

HALOGENATED HYDROCARBON – Any number of compounds composed of carbon and hydrogen which has a chlorine, fluorine or bromine constituent.

HIGH EFFICIENCY APPLIANCE – An appliance which operates at an AFUE value above about 83 percent. These appliances normally use a power burner, induced or forced draft blower or pulse combustion to vent the flue gases. The appliances also require special consideration of condensate. Between 83 and 90 percent AFUE condensate may occur in the vent system during cycling. If the AFUE value is above 90 percent condensate will occur in the appliance and vent system during cycling and steady operation.

LISTED – Equipment or materials included in a list published by a nationally recognized testing laboratory that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

MAKE-UP AIR – Air supplied to a space to replace air exhausted or otherwise removed from the space.

MULTIPLE APPLIANCE VENT – *(See Vent)*

NATURAL DRAFT – The motion of the flue gases through an appliance generated by hot flue gases rising in a chimney or vent.

PRIMARY AIR – The air introduced into a burner which mixes with the gas before it reaches the port or ports.

RELIEF OPENING – The opening provided in a draft hood to permit the ready escape to the atmosphere of the flue products from the draft hood in the event of no draft, back draft, or stoppage beyond the draft hood, and to permit inspiration of air into the draft hood in the event of a strong chimney updraft.

RETURN AIR – Air returning through ductwork to be reheated by a forced-air furnace after circulation through the heated space.

ROOF FLASHING – Metal used to waterproof roof joints or openings where vents emerge from the roof.

SECONDARY AIR – The air externally supplied to the flame at the point of combustion.

SLIP JOINT – Joints of metal vents so fabricated that vent sections can be secured to each other without tools by sliding the parts together manually.

SPACE, CONFINED – A space whose volume is less than 50 cubic feet per 1000 Btu per hour of the aggregate input rating of all appliances installed in the space.

SPACE, UNCONFINED – A space whose volume is not less than 50 cubic feet per 1,000 Btu per hour of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

SPILLAGE – Combustion products flowing from the appliance air openings or draft hood relief openings due to a malfunction of the venting system.

STORM COLLAR – A cone-shaped metal piece providing a waterproof transition from a vent pipe and a roof where the pipe emerges from the roof.

THIMBLE – A metal device penetrating a wall with a hole for a vent pipe to pass through. The thimble secures the pipe, seals the wall opening and insures that the hot vent is isolated from combustible wall material. A ventilated thimble has holes which allow air to pass freely between the vent and the thimble thereby keeping the thimble cool.

UPDRAFT – An increase in the upward velocity and volume of the flue gases caused by excessively low atmospheric pressures at the outlet of the chimney or vent cap.

VENT – *(See Gas Vents)* A device, such as a pipe, to convey flue gases from an appliance to the outdoors.

VENT CONNECTOR – That portion of the venting system which connects the gas appliance to the gas vent or chimney.

VENT DAMPER DEVICE, AUTOMATIC – A device intended for installation in the venting system, in the outlet of or downstream of the appliance draft hood, of an individual automatically operated fuel-gas burning appliance and which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

a. Electrically Operated. An automatic vent damper device that employees electrical energy to control the device.

b. Mechanically Actuated. An automatic vent damper device dependent for operation upon the direct application or transmission of mechanical energy without employing any type of energy conversion.

c. Thermally Acutated. An automatic vent damper device dependent for operation exclusively upon the direct conversion of the thermal energy of the vent gases into mechanical energy.

VENT GASES – *(Flue-Gases, Flue-Products)* Products of combustion from gas appliances plus excess air, plus dilution air in the venting system above the draft hood or draft regulator.

VENT TERMINAL (VENT CAP) – The fitting at the end of a vent pipe that directs the flue gases into the outside atmosphere and keeps out rain, snow, debris and animals.

VENTING – The process of removing the gases produced by combustion.

VENTILATION (VENTILATION AIR) – Air brought into or allowed to enter the space occupied by an appliance to replenish air used in combustion, excess air, and draft hood dilution air or to provide replacement of the air in a space by fresh air.

VENTING SYSTEM – The gas vent, chimney or single-wall metal pipe, and vent connector if used, assembled to form a continuous open passageway from the gas appliance to the outside atmosphere for the purpose of removing vent gases.

WATER COLUMN – Abbreviated as W.C. A unit used for expressing pressure. One inch water column equals a pressure of 0.578 ounces per square inch.

'Y" FITTING – A tee fitting modified in shape to reduce flow resistance.

Notes

Note: This publication is general in nature and is intended for INSTRUCTIONAL PURPOSES ONLY. It is not to be used for equipment selection, application, installation, or specific service procedures.