



SIZING HANDBOOK

SIMPSON

dv Dura-Vent

Complete step-by-step training manual and venting requirements for Category I draft hood-equipped and fan-assisted gas appliances.

SIMPSON DURA-VENT SIZING HANDBOOK

INTRODUCTION

Prior to the introduction of modern, efficient Category I gas appliances, much of the heat was lost up the flue. While this was not very energy efficient, it did provide for a powerful, hot draft that was relatively easy to vent. Because the flue gas was hot, condensation was not much of a problem, and corrosion problems were minimal. In most cases, the installer could simply size the vent to the outlet of the appliance.

With today's modern gas appliances, the installer is faced with the potential of major liability for vents that experience poor draft, corrosion failure, condensate leakage causing damage to walls and ceilings, condensate damage of the appliance, and leakage of toxic flue gases. The level of risk is increased due to the fact that these problems may go undetected at the time of installation. Corrosion is a slow process that may not become evident for two to three years. During this time, far too many improper installations could lead to a series of very costly failures.

Venting systems for modern Category I gas appliances will provide long lasting, trouble-free performance, but only if they are installed properly. It has become essential that the rules for proper sizing and installation be understood and closely adhered to.

Because the new rules and sizing tables are much more complicated than in the past, Simpson Dura-Vent is proud to take a leadership position in the industry by offering a handbook that is more than simply a list of confusing rules and tables that only an engineer could find enlightening.

FOREWARD

The Simpson Dura-Vent Sizing Handbook is a step-by-step training manual, written in straight forward terms. It starts off with the basic principles of venting, walks you through the logic of what the sizing tables are all about, and provides clear instruction on how to properly design and size your venting system.

The Simpson Dura-Vent Sizing Handbook is intended for the convenience and assistance of contractors, engineers, architects, building officials, and others concerned with the correct installation of venting systems for both draft-hood equipped and fan-assisted gas appliances.

This handbook contains general venting requirements and guidelines for both single and common vented appliances, manifold venting, multi-story venting, and venting into masonry chimneys.

The Simpson Dura-Vent Sizing Handbook contains venting requirements and sizing tables which are in full compliance with approved methods of vent design established in the national standards, such as the National Fuel Gas Code, ANSI Z223.1, NFPA 54, and NFPA 211 and the International Fuel Gas Code.

SDV Sizing Handbook

Tools for proper vent sizing

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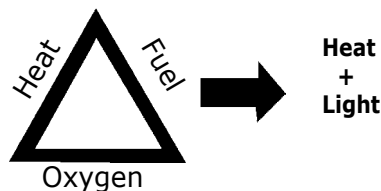
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SIMPSON DURA-VENT
ENGINEERED EXCELLENCE®

VENTING PRINCIPLES

In order to understand the principles of venting gas appliances, it is important to start with a basic understanding of the combustion process itself. Combustion is a chemical reaction that occurs so fast that

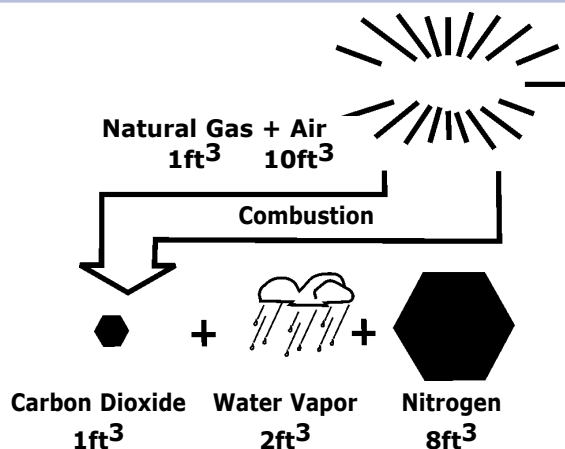
Figure 1.



it generates both heat and light. To produce combustion, it is necessary to combine three key ingredients; a fuel (such as natural gas or LP gas), a supply of oxygen (air), and heat (a source of ignition).

To achieve controlled combustion (as opposed to an explosion), it is important that the mixture of air and gas be in the correct proportions. When 1 ft³ of natural gas is burned, it combines with 10 ft³ of air. The result is not

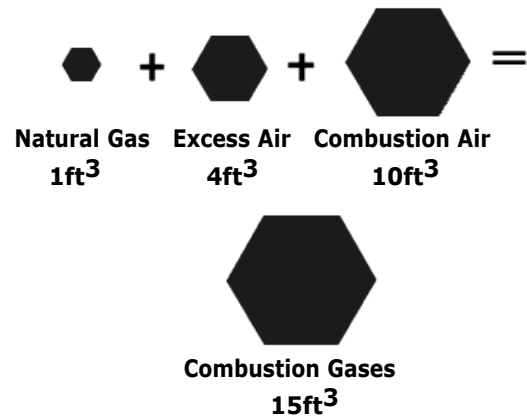
Figure 2



only a significant amount of heat (approximately 1000 - 1050 BTU's), but also some by-products of the combustion process; 1 ft³ of carbon dioxide, 2 ft³ of water in the form of a vapor, and 8 ft³ of nitrogen.

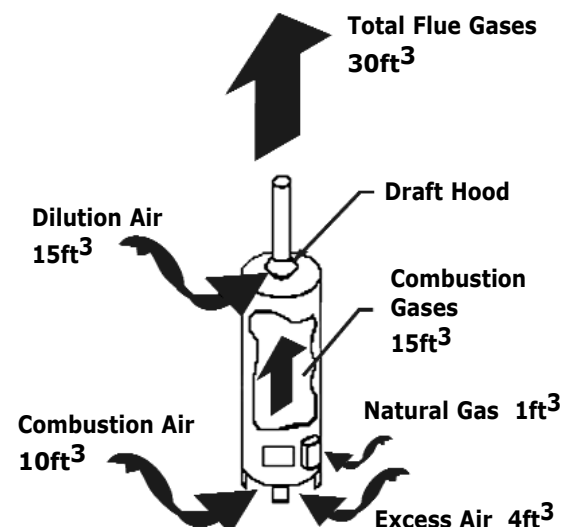
When less than 10 ft³ of air is supplied, incomplete combustion occurs, and carbon monoxide is produced instead of carbon dioxide. Since carbon monoxide is toxic, an extra amount of air is supplied to the chemical reaction to ensure that no carbon monoxide is produced. Gas appliances typically have 40 to 50% excess air (4 to 5 ft³ excess air for each 1 ft³ of natural gas).

Figure 3.



It appears that the volume of gas exhausted up the flue passage is not that great, however, more than 15 ft³ of flue gas is exhausted for each 1 ft of natural gas consumed. Now consider the fact that for every 15 ft³ of flue gas going up the flue, an equal volume of dilution air is added at the draft hood. Therefore, for typical draft hood - equipped appliances, the total volume of flue gas is 30 ft³ for each 1 ft³ of natural gas burned in the combustion process.

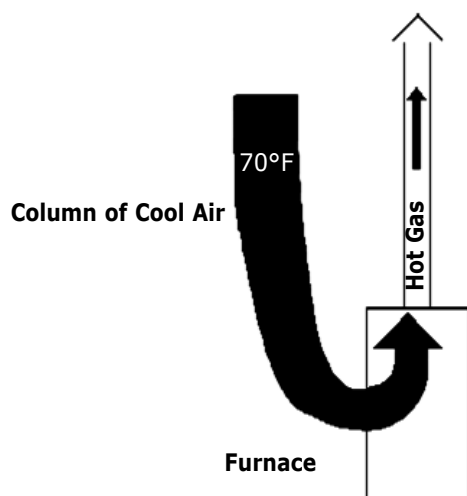
Figure 4.



To put this in perspective, a 100,000 BTU appliance will generate 3,000 ft³ of flue gas per hour. That is equivalent to the volume of gas contained in a room 10 ft wide, by 10 ft high, by 30 ft long. Not only is that a surprisingly large volume of gas, it also represents a great deal of weight. While gas is not thought of as having weight, the fact is that for every 100 ft³ of natural gas consumed by the appliance, 226 pounds of flue gas must be lifted up the flue.

With a natural draft appliance, the force that lifts this weight is heat. The force is created due to the difference in density (weight/cubic foot) between the hot flue gases and the relatively cool air surrounding the appliance. The greater the difference in temperature between the flue gas and the air, the greater the difference in density and the stronger the force becomes which pushes the flue gas up

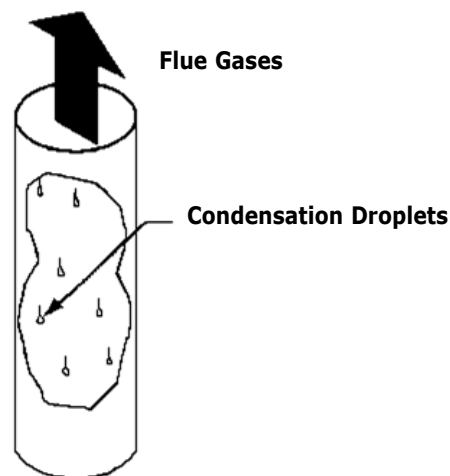
Figure 5.



and out of the vent. As the heavy cold air sinks to the bottom of the furnace room, it displaces the light warm flue gas.

Take a second to look at that chemical equation of the combustion process. (Figure 2) Not only has the combustion process created a much greater volume of gas that we must deal with, but it has also created a large quantity of water. A 100,000 BTU furnace produces 1 gallon of water every hour. The water is in the form of water vapor which is a harmless gas. However, if the flue gas is allowed to cool, there is a temperature at which the water vapor in the gas condenses out of the gas and forms water. The temperature at which condensation occurs is called the dew point temperature.

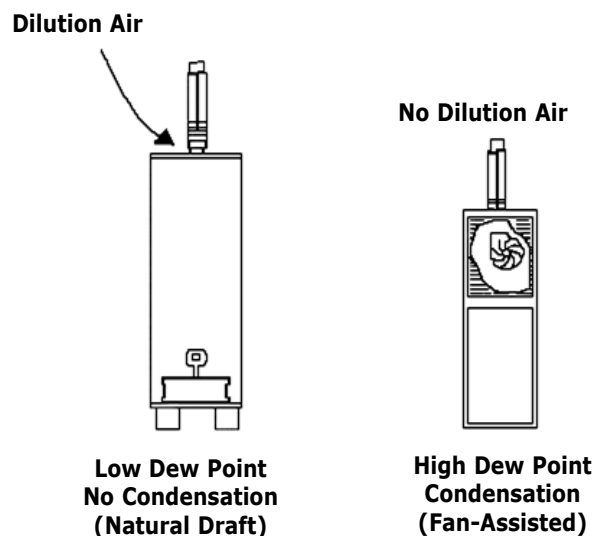
Figure 6.



A natural draft appliance, using 40 to 50% excess air, has a typical flue gas dew point temperature of about 121° Fahrenheit. If the amount of excess air in the combustion process increases or more dilution air is introduced at the draft hood, the dew point of the flue gas goes down in temperature. This means that the flue gas must cool to a lower temperature before condensation can occur, which is good. Unfortunately, the opposite is also true. If the draft hood (or draft diverter) is eliminated and no dilution air enters the vent, the dew point of the flue gas goes up in temperature and condensation is more likely. As discussed in the section covering gas appliances, this is one reason why the new fan-assisted gas appliances, which operate without a draft hood and no dilution air, have problems with excessive amounts of condensation.

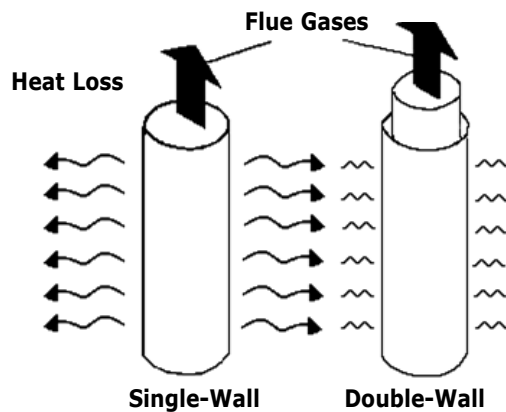
With these basic principals in mind, consider how this

Figure 7.



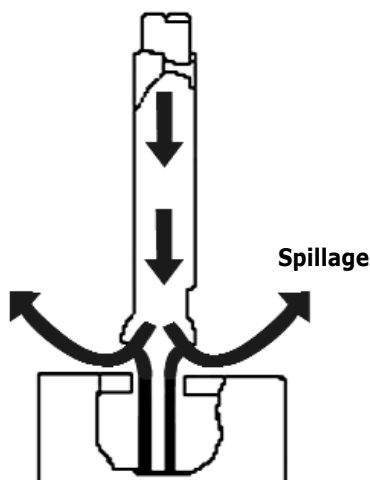
impacts venting. First, a strong draft is needed so that the appliance will operate properly and the flow of gas up the vent will not spill back into the appliance or out through the draft hood. To achieve a strong draft, it is important to keep the flue gases hot. Heat is the force that provides a strong draft. Be careful to minimize any heat loss in the venting system.

Figure 8.



Second, we need to keep in mind how gas appliances operate. When an appliance has remained off for several hours, the vent is cold. So when an appliance first turns on, the flue gas may not draft properly. In fact, it may lose so much heat because of the cold vent, that the flue gas backs up and spills out at the draft hood. As the vent heats up, the flue gas begins to draft properly, and the draft hood spillage stops. While it is normal to have a little draft hood spillage with a cold start, it should stop after a minute or two. A venting system must therefore be capable of heating up quickly from a cold start.

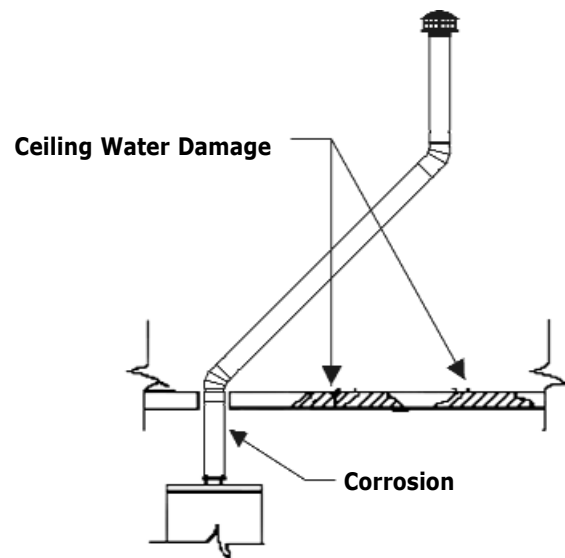
Figure 9.



A venting system must also heat up quickly and not lose too much heat during the on/off cycling of the appliance. With a draft hood appliance, cool dilution air continues to flow up the vent when the appliance is off. While this flow of air helps to dry up any condensation that may have formed in the vent, it also tends to cool the vent during the off cycle. Therefore, it is important for the vent to heat up quickly when the appliance cycles on, so as to avoid draft hood spillage at the start of each on cycle.

Draft hood spillage is not the only concern. It is also important to prevent condensation from forming in the vent, as the condensate can be very corrosive. It can leak out of the vent and cause water damage to walls and ceilings, it can rust out vent connectors and furnace heat exchanger; and it can attack the mortar in brick chimneys. It is important that the vent heat-up quickly to minimize the amount of condensation and to reduce the length of time that the vent stays wet. This is referred to as the wet time.

Figure 10.

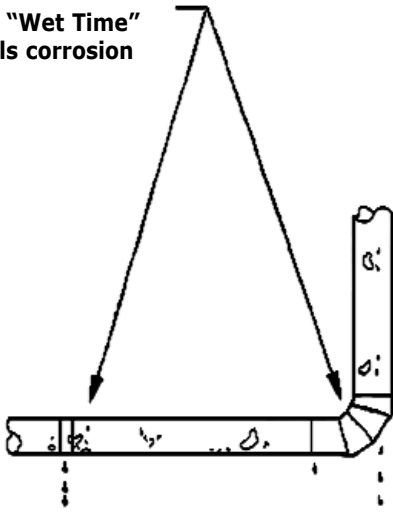


Studies conducted by Battelle Laboratories appear to confirm that corrosion occurs only when the vent walls are wet. While it is not uncommon for the vent to be wet when the appliance first cycles on, it is important that the vent walls heat up and dry out the condensation before the appliance cycles off. If the vent remains wet during the off cycle, this means that the vent may remain wet over long extended periods of time, and as a result, corrosion can take place.

Keeping the flue gas hot has always been a challenge in

Figure 11.

**Long "Wet Time"
equals corrosion**

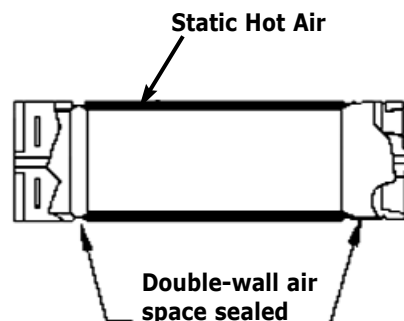


the field of venting, but one that has been fairly easy to overcome with good, common sense venting practices. Today, with the trend to improving the thermal efficiency of gas appliances, the challenge is much greater and the margin for error is much smaller than it has been in the past. It is now important that the sizing tables are used and that the rules for proper venting are followed. It is equally important that the installation instructions for the appliance and venting system are strictly followed.

TYPE-B GAS VENT COMPONENTS

Simpson Dura-Vent offers the most complete Type-B gas vent system on the market today, with several new component parts specifically designed to meet the new venting requirements for modern high efficiency gas appliances. The Simpson Dura-Vent Type-B gas vent features a twist-lock design that permits easy, rapid assembly and when necessary, the ability to disassemble the vent without causing damage to the locking mechanism. The vent design has been modified in recent years by incorporating an inverted bead construction to seal the air chamber between the inner and outer pipe, thus creating a hot, static air insulation system. Simpson Dura-Vent Type-B gas vent pipe is available in lengths from 6-inch to 5-feet, and vent diameters range from 3-inch up to 30-inch, as well as 4-inch, 5-inch, and 6-inch oval vent.

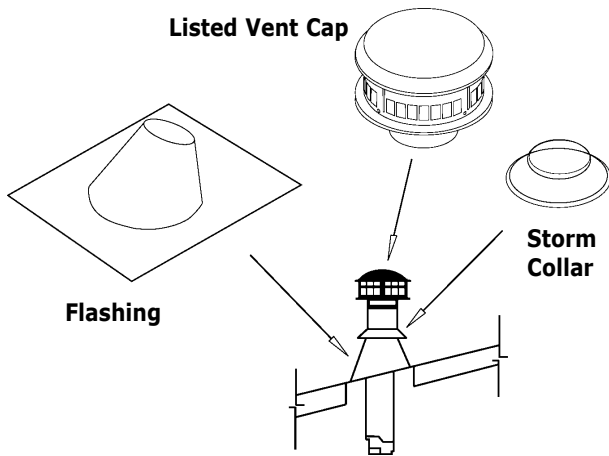
Figure 12.



The top termination basically consists of three component parts: the vent cap, designed to protect the vent from rain, snow, wind, downdraft, and birds, the storm collar, for sealing the top of the flashing, and the roof flashing which seals the roof penetration and prevents rain and snow leakage. The vent tops are available in both a DuraCap design, for architectural aesthetics, and a high wind cap, for commercial applications or installations demanding extreme wind protection such as, near mountains or along

a coast line. Flashings are available in a tall cone design for flat roofs, an adjustable flashing that accommodates roofs with flat to 6/12 pitches, and a steep roof flashing that accommodates roofs with a 7/12 to 12/12 pitch roof.

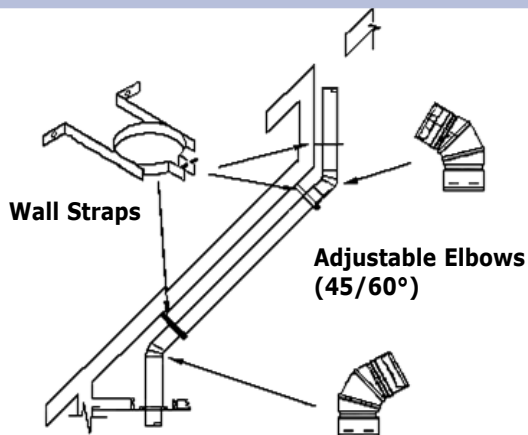
Figure 13.



Be sure to follow the “Vent Top Installation” rules contained in this handbook for positioning the vent at the correct height above the roof line and away from nearby walls, trees, etc. It is also very important to maintain a minimum 1-inch clearance to combustibles at the roof penetration. The flashing should be nailed to the roof. A non-hardening mastic should be used around the edges of the storm collar base and at the top of the flashing between the vent pipe and the flashing.

When running vent through a cold attic space, keep the run as short as possible and avoid the use of horizontal runs and 90° elbows. When offsets are required, it is preferable to use 45/60° elbows for a more gradual bend in

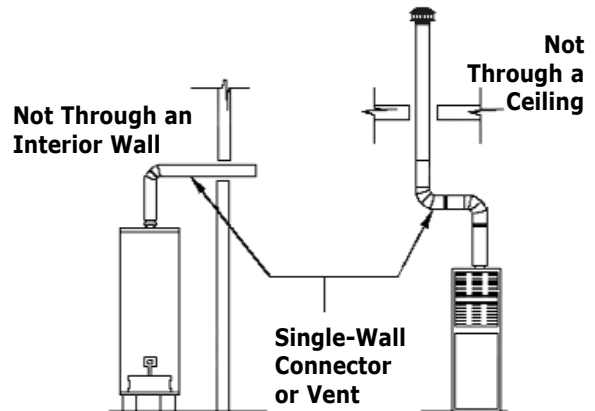
Figure 14.



the system. Be sure to properly support the vent pipe between elbows using wall straps or plumbers tape. Adjustable pipe lengths can provide the exact offset length required between elbows.

In extremely cold climates, avoid long runs of vent pipe passing through an uninsulated attic space. When passing Type-B gas vent through a closet or other occupied living space, an enclosure must be provided for fire safety reasons. (Be sure to maintain a 1-inch clearance.) Single-wall metal pipe is not permitted to originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space or floor. For passing single-wall pipe through exterior walls or roofs, a ventilated metal thimble must be used. Consult the National Fuel Gas Code for clearance to combustible

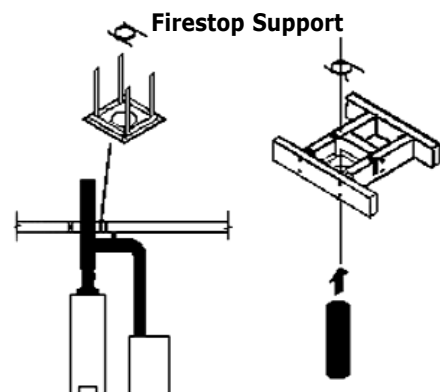
Figure 15.



requirements.

Whenever a floor or ceiling is penetrated with Type-B gas

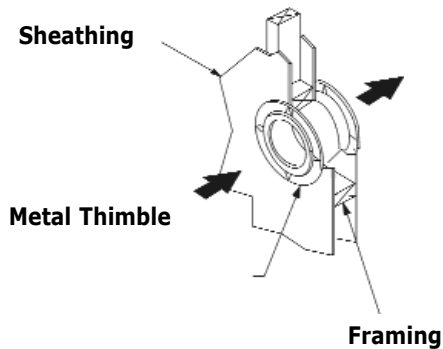
Figure 16.



vent, a U.L. listed firestop must be used. A firestop is a galvanized sheet metal plate that covers the opening made in the floor or ceiling. The opening should be large enough to provide for a 1-inch clearance between the pipe and any combustibles. Proper support of the venting system should be provided at the base of the system, in the form of a firestop support.

Whenever passing through a wall with a horizontal run of gas vent, a wall thimble must be used. Wall thimbles are

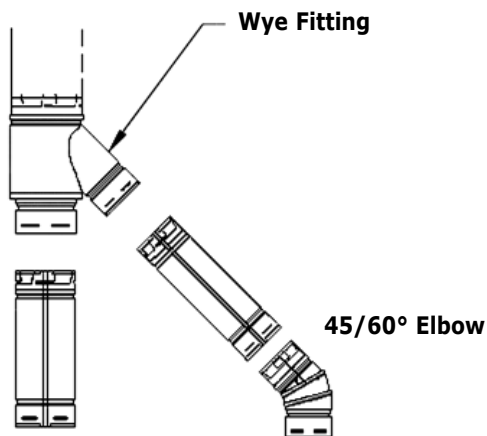
Figure 17.



adjustable, accommodating walls from 3 1/2-inch up to 6-inch thick.

For common venting two or more appliances, both standard and reduction tees are available in a wide range of sizes. The tee should be positioned as close to the ceiling as possible. Maintain a 1-inch clearance between the branch of the tee and the combustible ceiling. Whenever possible, instead of using 90° elbows in combination with a tee, use 45/60° elbows in combination with the new Simpson Dura-Vent double-wall wye. The

Figure 18.



wye fitting provides a more gradual bend, with far less resistance to the flow of the flue gas.

For applications requiring a Type-B gas vent connector, instead of single-wall pipe and fittings, the double-wall reduction wye will be of tremendous value. The installer should also maintain a suitable inventory of short 6-inch lengths of pipe and a supply of male and female adapters. These adapters serve as short, 6-inch long adjustable lengths which will be needed for short offsets in tight fitting installations. Remember, Type-B gas vent cannot be cut to length like single-wall galvanized pipe.

Figure 19.

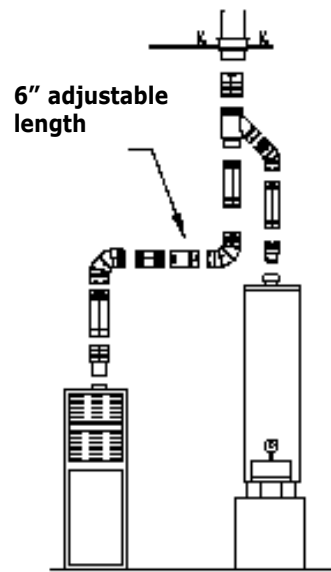
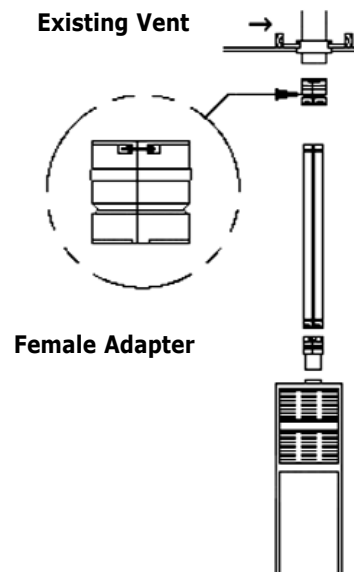
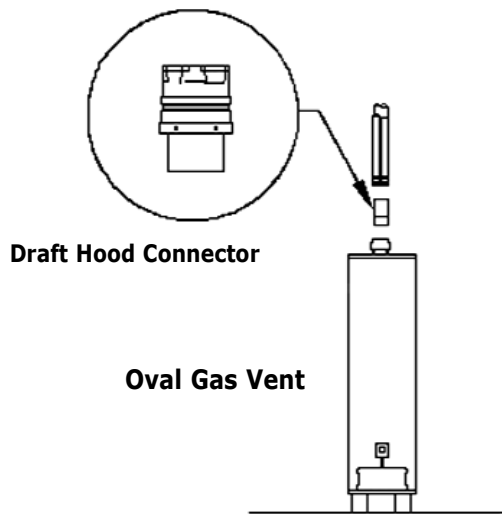


Figure 20.



For retrofit installations requiring a Type-B gas vent connector, it will be necessary to adapt the Simpson Dura-Vent product to the existing vent previously installed in the structure. The female adapter is designed to slip over the existing vent (all major brands) and provides for a U.L. listed transition to our twist-lock fittings.

Figure 21.



For connecting the appliance to the vent, a draft hood connector is available in sizes 3-inch through 24-inch. The draft hood connector should be fastened to the flue collar on the appliance.

Type BW oval gas vent is designed and listed for installation in the wall space between studs and is commonly used with wall furnaces. Oval gas vent is typically used on the first floor level, with the vent converting to round gas vent in the attic space. However, oval gas vent may be used for the entire run, terminating with an oval flashing, storm collar, and oval vent top.

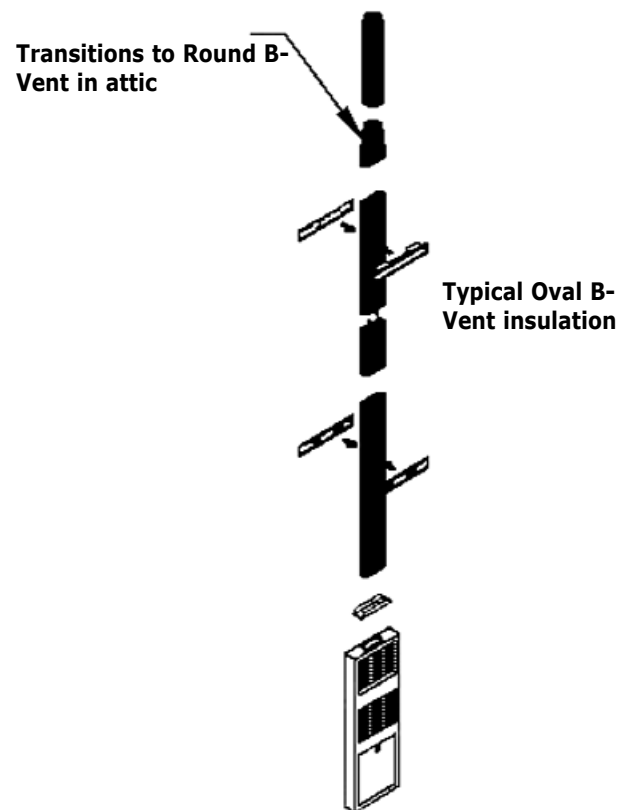
Simpson Dura-Vent 4-inch and 5-inch oval vent is U.L. listed for installation in a 2 x 4 stud space, with a less than 1-inch clearance to nearby combustibles. Simpson Dura-Vent's 6-inch oval vent does require a 1-inch clearance to combustibles when installed in a 2 x 6 wall space.

The basic component parts for oval vent are quite similar to round vent with various lengths of pipe, an adjustable length, elbows, tees, flashings, storm collars, and oval tops. In addition, an oval-to-round transition adapter is available. The stud space in which the vented wall furnace is installed must be ventilated at the first ceiling level by

installation of ceiling plate spacers. Firestop spacers must be installed at each subsequent ceiling or floor level penetrated by the vent.

WARNING: Before installing the venting system, be sure to read through all of the installation instructions included with the vent materials. Also, be sure to read and follow all operating and installation instructions provided by the appliance manufacturer. Failure to install the venting system in accordance with the installation instructions will void the manufacturer's warranty and may have an effect on the U.L. listing status and the homeowner's insurance. It is also very important to review local building codes to ensure that all installations are in full compliance with the rules and regulations adopted by local building authorities.

Figure 22.



GAS APPLIANCES

TYPES OF APPLIANCES

The venting requirements and sizing tables in this handbook apply to gas appliances which have been listed by a recognized listing agency, such as the American Gas Association.

Appliances must be approved, certified, or listed by a laboratory that maintains recognized test standards and listing services.

The sizing tables apply to:

1. All gas burning appliances equipped with draft hoods or draft diverters, and
2. All gas burning appliances listed as Category I with draft hoods, fan-assisted or induced draft systems.

The venting requirements and sizing tables in this handbook are applicable to a wide range of gas appliances, including:

- Water Heaters
- Vented Room Heaters
- Central Warm Air Furnaces
- Duct Furnaces
- Low Pressure Boilers
- Conversion Burners
- Unit Heaters
- Floor Furnaces

APPLIANCE REGULATIONS

In 1987, the National Appliance Energy Conservation Act (NAECA) was passed by the United States Congress and signed into law by the President. This law established minimum efficiency standards for residential gas furnaces and water heaters as well as many other types of appliances.

Prior to 1987, the majority of gas furnaces and water heaters installed in the United States were draft hood-

equipped models with thermal efficiencies around 75%.

For gas water heaters, the new minimum energy factor has been set at 0.54 for a 40 gallon unit, effective January 1, 1990. To meet the 0.54 energy factor requirement, water heater manufacturers typically have to design their products with thermal efficiencies around 75%, so draft hood-equipped water heaters have been retained under the present standards.

For gas furnaces, the law set the minimum Annual Fuel Utilization Efficiency (AFUE) at 78%, effective January 1, 1992. The net effect of this new standard has been the gradual phase-out of draft hood-equipped furnaces in favor of furnaces with fan-assisted combustion systems.

APPLIANCE DESIGN

NATURAL DRAFT APPLIANCES: Draft hood-equipped appliances operate with a non-positive vent pressure. The heat of the flue products provides the thermal lift to achieve a strong draft in the vent, with cold air entering the combustion chamber to replace hot air rising up the flue. The draft hood allows dilution air to enter the vent system, ensuring that the vent will continue to function, even in the event that the appliance malfunctions. The draft hood also serves as a relief opening in the event that the flue becomes blocked or experiences a downdraft.

Recent studies conducted by Battelle Laboratories, under the direction of the Gas Research Institute, appear to indicate that dilution air entering at the draft hood is also highly beneficial. The flow of dilution air, mixing with the flue gas products, tends to lower the dew point of the flue gas. This means that the flue gas must cool to a lower temperature before condensation can occur. The continuous flow of dilution air also tends to dry out the vent during the off cycle of the appliance, thus further

Figure 23.

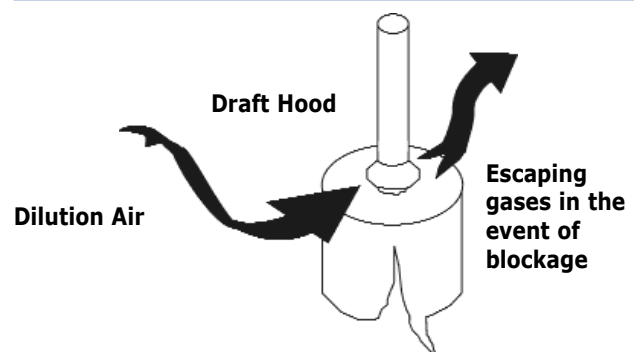
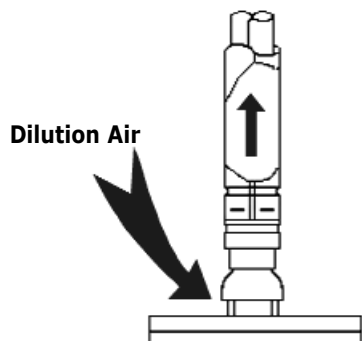


Figure 24.



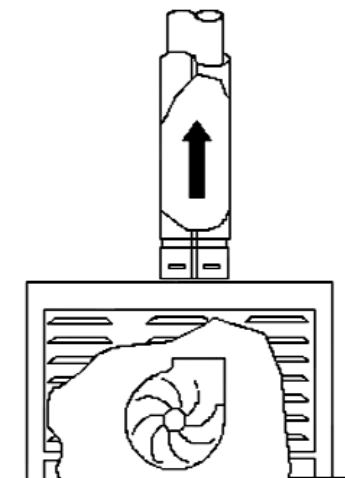
reducing the possibility of condensate corrosion.

The vast majority of water heaters on the market today continue to be draft hood-equipped appliances. These are natural draft appliances, and meet the minimum water heater efficiency standards of 0.54 energy factor (75% AFUE). As a result, the methods of venting water heaters and the values listed in the sizing tables remain essentially identical to previous publications of the Simpson Dura-Vent Sizing Handbook.

FAN-ASSISTED APPLIANCES: To meet the 78% minimum efficiency standard mandated in the National Appliance Energy Conservation Act, the design and construction of gas furnaces has changed considerably over the past several years. Gas appliance manufacturers have developed fan-assisted combustion systems using fans to achieve either an induced or forced flow of combustion air. The higher internal flow rates and velocity of the combustion gases have resulted in a major improvement in combustion efficiency.

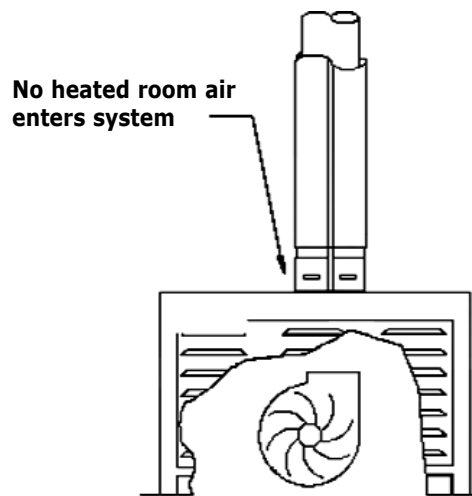
Elimination of the draft hood has also improved overall

Figure 25.



efficiency by no longer permitting heated air in the building to escape up the vent, both when the appliance is operating and when it is not.

Figure 26.



Because the flue gas temperatures are much cooler with a fan-assisted appliance, the tendency to form condensate becomes greater. Without a draft hood to provide dilution air, the dew point of the gas rises and, thus, condensation can occur at a higher temperature and, furthermore, no dilution air is available to dry out the vent during the appliance off cycle.

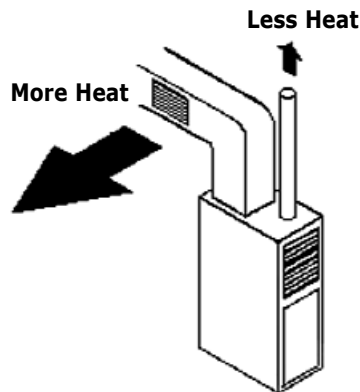
Fan-assisted gas appliances must be vented in strict accordance with the venting requirements and sizing tables in order to avoid potential draft, condensation, and corrosion problems.

APPLIANCE CATEGORIES

As the thermal efficiency of the appliance increases, less and less heat is lost up the flue. For example, a 70% efficient appliance extracts 70% of the heat of combustion for supply to the building, with 30% of the heat exhausted up the flue. As the appliance efficiency increases to 80%, the heat lost up the flue is reduced by one third to 20%. In other words, for a 10% increase in appliance efficiency, the heat content of flue gas drops 33%.

The gas appliance industry has developed several new types of "fan-assisted" gas appliances engineered to achieve higher levels of combustion efficiency. In some appliance designs, the fan is simply used to improve the combustion efficiency by increasing the flow of air through

Figure 27.



the combustion chamber. The fan is not used to force the flue gas up the venting system. In contrast, some “fan-assisted” appliance designs do use the fan to assist the flow of gas up the venting system, thereby creating a positive pressure in the vent. It should also be noted that some appliance designs may be condensing, requiring a water tight corrosion resistant venting system, while other appliance designs are non-condensing and can be vented with standard Type-B Gas Vent. To ensure that the proper vent is matched to these new types of appliance designs, a system of appliance “categories” have been adopted by the industry.

While no formal categorization exists for water heaters, at this time, most of these appliances are draft hood-equipped and operate with non-positive vent pressure and flue gas temperatures of at least 140° F above its dew point. Water heaters are typically vented with Type-B Gas Vent.

Category I fan-assisted appliances are designed to operate with a non-positive vent pressure and with a flue loss of not less than 17%. While a fan is necessary to provide an adequate flow of combustion air through the appliance, the fan is not intended to assist the flow of flue gas up the vent. The flow of flue gas up the vent is dependent on the heat content of the flue gas (buoyancy). The pressure in the vent remains non-positive, as is the case with draft hood-equipped appliances. Category I gas appliances typically operate within an efficiency range of 78% to 83% AFUE and are commonly vented with Type-B Gas Vent.

Category II gas appliances are defined as appliances which operate with a non-positive vent pressure and with a flue loss less than 17%. Category II appliances must rely on heat (buoyancy) in the flue gases to achieve a natural draft (non-positive vent pressure). Yet by definition, the flue gas is very cool (less than 17% flue loss) and, therefore, it is difficult to achieve a natural draft. Hence, Category II appliances are considered condensing appliances and have special venting

requirements as specified by the appliance manufacturer.

Category III gas appliances are designed to operate with a positive vent pressure and a flue loss of not less than 17%. Category III appliances utilize a fan not only to assist the flow of air through the combustion chamber, but also to assist the flow of flue gas up the vent. As a result, a positive pressure exists in the vent. It is also noted that Category III type appliances tend to be borderline condensing. In order to contain the positive pressure in the venting system, plus provide for a water tight, corrosion resistant venting system, Category III gas appliances typically utilize special venting, as required by the appliance manufacturer. Category III appliances typically operate in the 78% to 83% AFUE efficiency range.

Category IV gas appliances are designed to operate with a positive vent pressure and with a flue loss less than 17%. Category IV gas appliances utilize a fan to assist the flow of gas up the vent, thereby creating a positive pressure in the vent. It should also be noted that since Category IV appliances typically operate at over 90% AFUE efficiency, the flue gas is very cool and, as a result, significant quantities of condensation can occur in the venting system. For this reason, high efficiency Category IV gas appliances typically utilize special venting, as required by the appliance manufacturer. These venting systems may be sealed to contain the positive vent pressure, as well as to provide resistance to condensate corrosion and condensate leakage.

Draft hood-equipped gas appliances are listed only as Category I appliances since they are a non-condensing appliance and operate with a non-positive vent pressure. Fan-assisted combustion appliances may fall into any of the four categories: I, II, III, or IV. Note that some fan-assisted appliances may be listed as a Category I appliance, provided it is vented in a standard vertical type installation, but is considered a Category III appliance in the event that it is vented in a horizontal type application. This is due to the higher back pressure that occurs with a short horizontal vent.

Check the label on the appliance to determine to which category the appliance is listed as, and follow the appliance manufacturers’ installation instructions.

IMPORTANT: The venting requirements and sizing tables contained in this handbook are intended only for Category I draft hood-equipped or fan-assisted appliances, or for combinations of these two types of appliances. For proper sizing of venting systems with Category II, III, or IV appliances, refer to the appliance manufacturers’ installation instructions.

GENERAL RULES

Proper gas venting should perform the following functions to insure safe and dependable operation of the appliance:

1. Safely vent all of the hot combustion gases to the outside atmosphere.
2. Prevent overheating of nearby walls or framing.
3. Control condensation of water vapor present in combustion gases.
4. Provide fast priming of the vent.

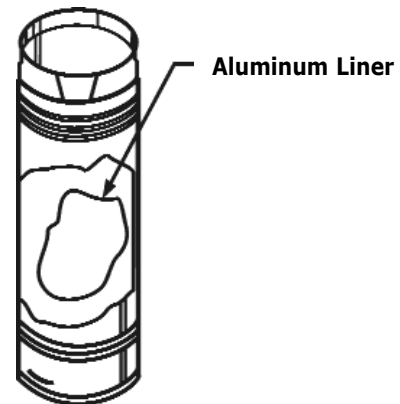
TYPE-B GAS VENT

The amount of heat the vent gases lose as they flow determines how much condensation will occur and how strong the draft will be. To control the heat loss, proper selection of venting materials is of vital importance.

Type-B double-wall gas vent, with an aluminum inner wall and a galvanized steel outer wall, has proven to be the ideal choice in venting materials for several important reasons:

1. The double-wall, air insulated design keeps the flue gases hot inside the vent, while maintaining a cool outside wall temperature. This provides for a strong draft with minimal condensation and permits the vent to be installed with a 1-inch clearance to nearby combustibles.
2. The aluminum inner wall heats up rapidly because the aluminum has a low mass and high thermal conductivity, presenting a warm surface to the vent gases. Condensation forms only briefly on the vent walls, which reduces the wet time and the potential for corrosion.
3. The aluminum inner wall is corrosion resistant to condensation that may form in the vent, which provides a safe, long lasting installation.

Figure 28.



SINGLE-WALL CONNECTORS

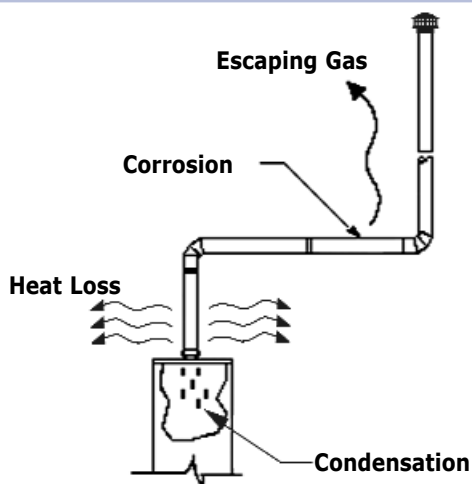
Following the introduction of the more efficient, Category I (78 - 83% AFUE) gas appliances in the mid 1980's, the industry began to receive field reports that galvanized steel vent connectors were failing due to severe pitting and general corrosion.

An in-depth investigation conducted by the American Gas Association appears to conclude that single-wall galvanized connectors permit a greater heat loss than double-wall, air insulated vents, and the result is a tendency for more condensation in the vent connectors.

In response to this problem, new sizing tables and new venting requirements were developed by the industry that serve to restrict the use of single-wall galvanized connectors. The type of appliance (fan-assisted vs. natural draft), BTU of the appliance, length of connector, total height of the vent system, ambient temperature conditions, and other factors must now be evaluated to determine if a galvanized steel vent connector can withstand the operating conditions.

While the basic sizing table approach of limiting wet times is a valid method of solving the corrosion problem, it does present a complicated and often borderline solution. As an alternative, Simpson Dura-Vent approached this problem with a metallurgical solution. Our basic approach is to replace the galvanized steel with aluminum. This provides for a much higher level of corrosion resistance as evidenced by the outstanding performance of aluminum as the inner liner in Type-B gas vent. The aluminum also heats up more rapidly due to its low mass and high thermal conductivity, reducing the wet time by up to 50% as compared to galvanized steel.

Figure 29.



The Dura/Connect system is manufactured out of .010-inch thick, 2005 aluminum flex, identical to the inner liner material in Type-B gas vent. All fittings are manufactured out of aluminum coated steel, and the connector system provides the protection of a 10-year warranty.

The Dura/Connect system offers the contractor a corrosion resistant, flexible single-wall vent connector, including:

- U.L. listed to a 1-inch clearance to combustibles
- Approved and listed by I.C.B.O., B.O.C.A., S.B.C.C.I.
- Corrugated flex with built-in twist-lock fittings cut installation time by 80%

Simpson Dura-Vent does NOT recommend the use of

Figure 31.



Simply TWIST-LOCK AND CONNECT the Dura/Connect product for easy installations, fast!



single-wall galvanized steel connectors. When the sizing tables indicate that single-wall connectors may be used, we recommend the use of the Dura/Connect

system or Type-B gas vent. For installations when the sizing tables indicate that Type-B gas vent must be used as the vent connector, we recommend that the installer follow the sizing table recommendations.

Typical common vent installations combining a fan-assisted furnace with a draft hood-equipped water heater may be

Figure 30.

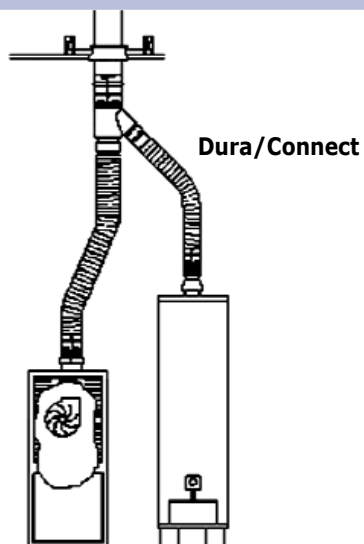
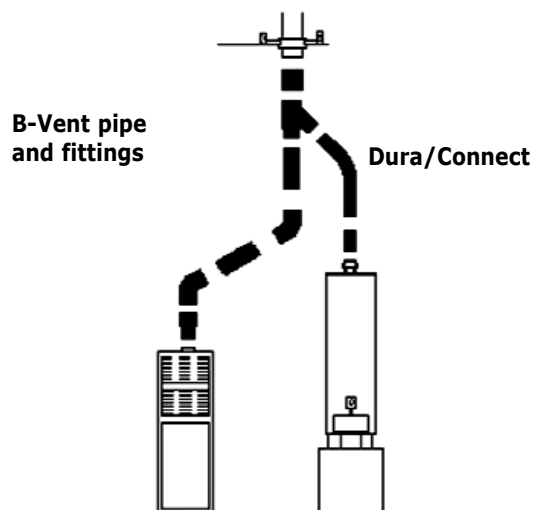


Figure 32.



connected using a double-wall wye fitting, with double-wall Type-B gas vent connected to a fan-assisted furnace, and Dura/Connect to the natural draft water heater as shown in Figure 32.

It is important that the rules and regulations pertaining to vent connectors be followed. Long connector runs in cold air spaces such as garages or attics can result in serious corrosion problems and condensate damage to walls and ceilings. The National Fuel Gas Code states that, “vent connectors located in, or passing through a crawl space or other area which may be cold, must be a listed, double-wall, Type-B gas vent or vent material having equivalent insulation qualities.”

Additional requirements contained in the National Fuel Gas Code include:

1. The entire length of single-wall metal vent connectors shall be readily accessible for inspection, cleaning, and replacement.
2. Vent connectors serving Category I appliances shall not be connected to any portion of mechanical draft systems operating under positive pressure such as Category III or Category IV systems.

Rules pertaining to vent connector maximum length, sizing, connector rise, number of elbows, and proper vent configuration are also very important and should be closely adhered to.

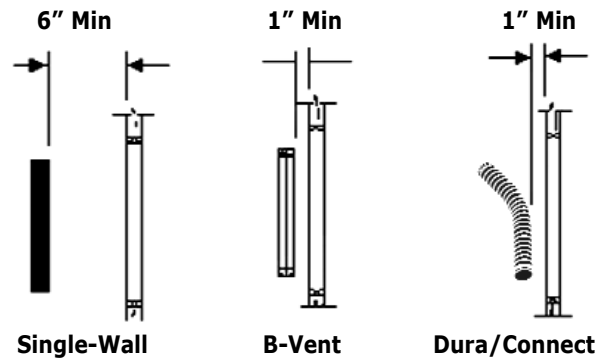
FIRESAFE INSTALLATION

The most important rule in venting gas appliances is to maintain proper clearance between the vent pipe and nearby combustibles. Type-B Gas Vent is U.L. listed with a minimum 1-inch clearance (air space) to nearby combustibles. The Simpson Dura-Vent single-wall aluminum vent connector, Dura/Connect, is also U.L. listed for installation with a 1-inch clearance to combustibles, providing it does not pass through walls or ceilings. Single-wall galvanized steel connectors are not U.L. listed and must be installed with a minimum 6-inch clearance to combustibles.

Failure to observe proper clearances between the vent pipe and nearby combustibles is considered to be a very serious fire hazard. It is absolutely essential that proper clearances

are observed at all times.

Figure 33.

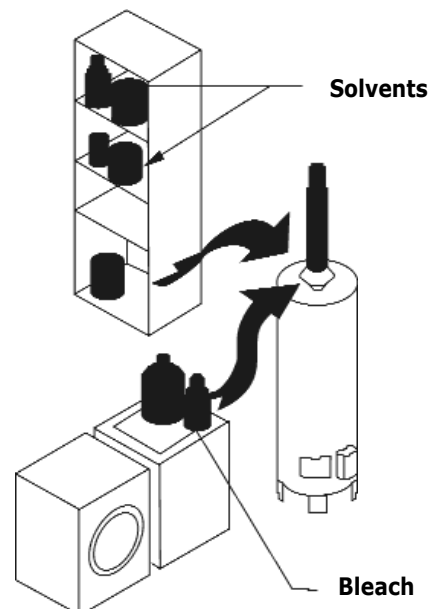


PROVIDING AIR SUPPLY

An adequate supply of fresh air must be provided for satisfactory performance of the appliance and venting system. Refer to the National Fuel Gas Code, NFPA Standard No. 54, ANSI Z223.1 and this handbook for suggestions on how best to insure an adequate supply of air.

Note that contaminants in the air supply have a major impact on appliance and vent corrosion. Recent studies conducted by Battelle Laboratories indicate that severe

Figure 34.

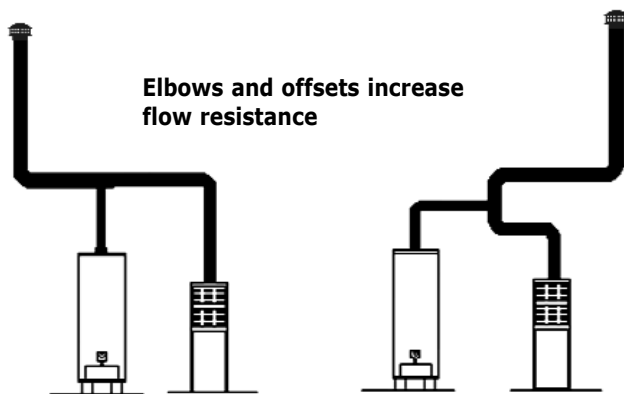


corrosion is often related to air intake from laundry rooms, which may contain chlorides from laundry bleaches. Solvents found in garages are another potential source for air contaminants. When outdoor air is used as a supply source for combustion, corrosion problems tend to be reduced.

AVOIDING DRAFT RESTRICTIONS

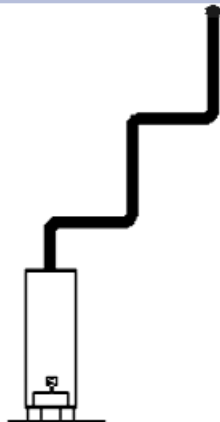
Restrictions to the flow of flue gases are of major concern when planning an installation. The ideal vent configuration travels in a straight vertical line from the appliance flue collar to the vent top termination. Hot flue products try to travel straight up. Unfortunately, this is not always possible.

Figure 35.



When designing a vent system, it is important to keep the number of elbows to a minimum. Each additional elbow serves as a restriction to the flow of the flue gas. When elbows are required, it is preferable to avoid sharp bends, such as 90° elbows, and instead favor more gradual bends, such as a 45° or 60° elbow.

Figure 36.

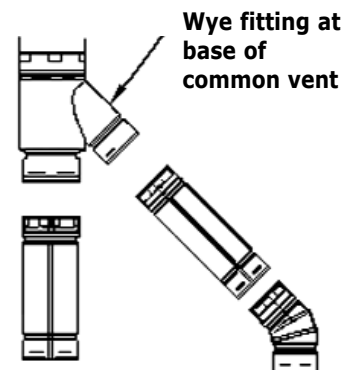


While there is no set maximum number of elbows that may be used, the use of more than two pairs of elbows (four elbows) should be avoided if at all possible.

There is no need to install a vent tee on a single appliance gas vent system. Gas appliances are clean burning and do not create deposits in the flue requiring a clean-out tee. Do not install a tee directly off the appliance. This will only serve as a major obstruction to the flow of the flue gas.

For common vented appliances, a vent tee may be required as the junction member. Keep in mind that a tee is more restrictive to the proper flow of flue gas than even an elbow. Whenever possible, use a vent wye in place of a vent tee to keep restrictions to a minimum. Gradual bends such as 45°/60° are favored over sharp 90° bends.

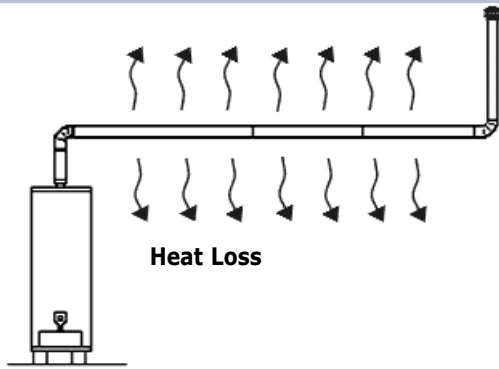
Figure 37.



Since the flue gas tries to go up, it is important to avoid long horizontal runs (also referred to as lateral runs). Long horizontal runs restrict the flow of the gas. Restrictions on the length of horizontal runs for both vents and vent connectors are explained in the sizing table rules of this handbook and should be adhered to. A long horizontal run is just as restrictive as too many elbows. Long horizontal runs, particularly with single-wall connectors, can also result in too much heat loss.

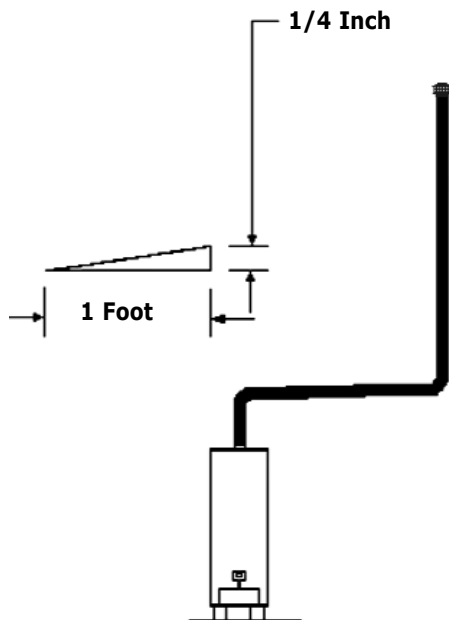
When horizontal runs are required, the vent should be installed with a rise of 1/4-inch per foot to avoid having condensate collect in the vent and to insure upward travel of the flue gases. The rise should be such that any condensate will run back towards the appliance. In no case should the venting system be installed in a manner that creates a valley where condensate could collect and lead to rapid corrosion.

Figure 38.



A common mistake in vent system design is not permitting sufficient rise above the appliance outlet before entering a common vent or entering a lateral run. In effect, the flue gas needs to gain some momentum and develop into a strong draft before it encounters any restriction. Do not elbow directly off the top of the appliance. If horizontal or lateral routing is necessary, provide the maximum vertical rise first, before making the lateral run.

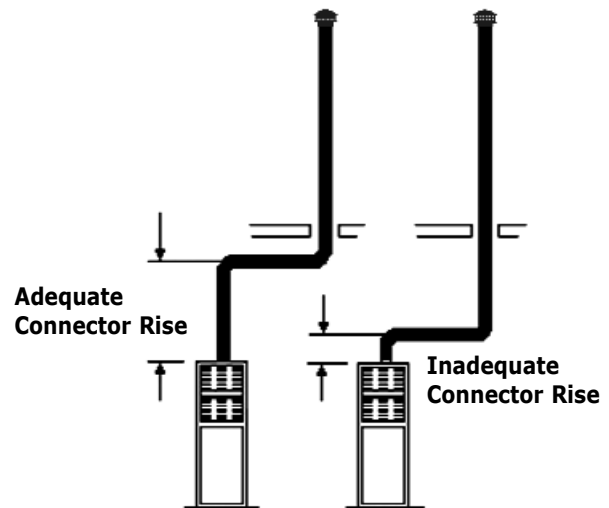
Figure 39.



MINIMUM VENT HEIGHT

The total height of the vent (the distance from the appliance draft hood or flue collar to the top termination) is very important in achieving a proper draft. If the vent height is too short, the draft will be weak and highly sensitive to downdraft. The vent should terminate a minimum of 5 feet in vertical height above the appliance flue collar.

Figure 40.



When installing multiple appliances with a common vent (such as in a multi-story apartment building), the vent should terminate a minimum of 5 feet in vertical height above the highest connected draft hood or flue collar. For appliances installed in attics, as well as unit heaters hung from ceilings, the minimum vent height of 5 feet must be observed, even if this means that the vent must rise several feet above the roof line.

For wall furnaces, or vented recessed wall heaters, the vent must terminate at least 12 feet above the bottom of the appliance. In the case of combined vents, the 12-ft minimum vent height is measured from the bottom of the appliance to the point of interconnection with a common vent. Most wall furnaces are placed in 2 x 4 stud walls and require a Type BW (oval) vent installation.

Figure 41.

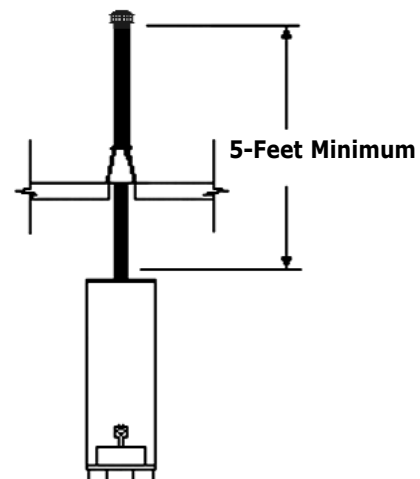
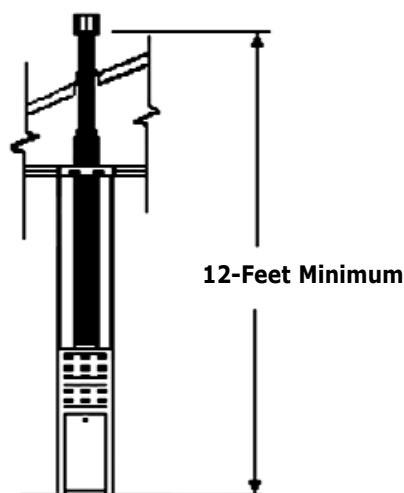


Figure 42.



OUTDOOR VENTS

Installing vents on the exterior of a building is not recommended. Exposure to the cold outdoor air will result in excessive heat loss, poor draft and vent condensation. Outdoor vents serving indoor appliances also tend to backdraft. This can occur when the pressure inside the building is less than the pressure outside, or when warm air inside the building is rising, drawing cold air in through the vent.

If a vent must be installed on the exterior of a building, it is recommended that an insulated chase be constructed to maintain relatively warm temperatures surrounding the vent. Seal the chase properly for maximum insulation value, and maintain 1 inch clearance between the vent and nearby combustibles.

To avoid backdrafting with an outdoor vent, it is recommended that an enclosure or furnace room be constructed that will serve to isolate the appliance from the inside of the building. An outdoor air supply should be provided which will serve to equalize the pressure and minimize any backdraft. The use of U.L. listed vent caps is strongly recommended.

VENT CAP DESIGN

With the trend to higher appliance efficiencies, and thus lower flue gas temperatures, the design of the vent cap has become far more critical to proper venting performance. All of the Simpson Dura-Vent vent caps, including our DuraCap, high wind cap, and roof-jack combo cap have

been designed, engineered and tested at Underwriter's Laboratories to exceed optimum performance standards.

The use of vent caps, or roof jacks, supplied by local fabricators may cause serious flow restrictions, excessive condensate and corrosion problems, leakage of gas into attic areas, and can result in high sensitivity to adverse wind and rain conditions. The use of U.L. Listed vent caps is strongly recommended.

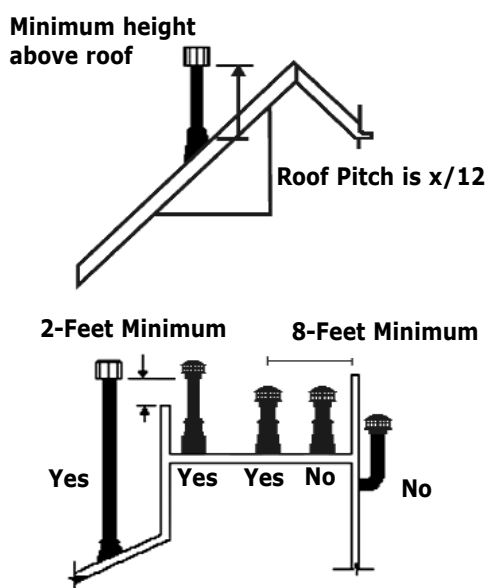
VENT TOP INSTALLATION

The location selected for the vent top can have a significant influence on proper draft performance. On a windy day, nearby obstructions such as a wall or tree can create a zone of high pressure. When the vent cap is located in these high pressure zones, the vent becomes highly susceptible to windy conditions and may tend to backdraft. In those cases when the vent must be installed in a position less than 8 feet from a wall, parapet, or other obstruction, the vent cap must be located at least 2 feet above the obstruction.

High pressure zones can also be created by wind striking the roof itself. For roofs from flat to 7/12 pitch, the vent cap should be positioned at least 1 foot above the roof surface. As indicated in Figure 43, measure the vertical distance between the roof surface and the lowest discharge opening on the vent cap.

As the roof pitch increases above 7/12, the roof begins to act more like a wall, and the pressure zone increases. To compensate for this, it is necessary to increase the height of the vent. The steeper the roof, the greater the vent height required to avoid the high pressure zone. Refer to the table in Figure 43 listing minimum heights for roof pitches greater than 7/12.

Figure 43.



The reason is that the volume of the flue products does not change with altitude. Therefore, the vent system should be designed based on the sea level BTU input rating.

For appliances which can be operated at multiple inputs, design the venting system assuming the maximum sea level input rating. If the appliance has been derated, use the actual input at altitude for determining the minimum vent capacity.

Gas Vent Termination Table

<u>Roof Pitch</u>	<u>Minimum Height</u>
Flat to 7/12	1.0 feet*
Over 7/12 to 8/12	1.5 feet
Over 8/12 to 9/12	2.0 feet
Over 9/12 to 10/12	2.5 feet
Over 10/12 to 11/12	3.25 feet
Over 11/12 to 12/12	4.0 feet
Over 12/12 to 14/12	5.0 feet
Over 14/12 to 16/12	6.0 feet
Over 16/12 to 18/12	7.0 feet
Over 18/12 to 20/12	7.5 feet
Over 20/12 to 21/12	8.0 feet

* This requirement covers most installations

For gas vents 12 inches in size or smaller, the vents may terminate in accordance with the minimum heights listed in Figure 43 provided they are at least 8 feet from a vertical wall or similar obstruction. All other gas vents must terminate not less than 2 feet higher than any portion of a building within 10 feet.

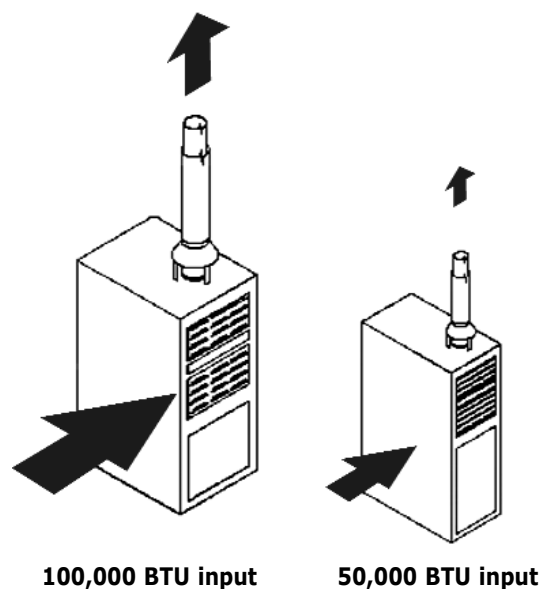
CORRECTION FOR ALTITUDE

The vent system should always be designed for the sea level name plate input rating of the appliance, regardless of the actual derated operating input required by the local altitude.

PRINCIPALS OF VENT SIZING

While several factors determine the size of a vent system, the most important consideration is the “Appliance Input Rating.” The larger the appliance input rating, the greater the volume of gas that the vent system must be capable of handling. For example, a 100,000 BTU per hour appliance is going to require a larger size vent than a 50,000 BTU per hour appliance. The larger appliance is not only consuming more natural gas (BTU’s) every hour, but it is also exhausting more flue gas. The greater the volume of gas, the larger the vent diameter must be so the gas will not backup and spill out at the draft hood or, in the case of a fan-assisted appliance, cause the vent to become pressurized.

Figure 44.



NATURAL DRAFT APPLIANCES

A sample sizing table for a single, natural draft appliance is illustrated in Figure 45. Note the vent and connector diameters located across the top of the table and the list of BTU’s under the columns entitled “NAT MAX”. The BTU values indicate the maximum volume of gas (BTU’s) that can be vented through a given vent diameter. For example,

in the column under 3-inch vent diameter, the BTU values are in the 30,000 to 40,000 BTU range. Note that the BTU values under the 4-inch vent diameter column have increased up to the 60,000 to 90,000 BTU range. As expected, the sizing table is indicating that a larger volume of gas can be vented through a 4-inch vent diameter than through a smaller 3-inch vent diameter.

Figure 45.

Appliance Input Rating in Thousands of BTU Per Hour

Height H (ft)	Lateral L (ft)	NAT max	NAT max
6	0	46	86
	2	36	67
	4	34	64
	6	32	61
8	0	50	94
	2	40	75
	5	38	71
	8	35	66
10	0	53	100
	2	42	81
	5	40	77
	10	36	70

A second factor that determines the size of a vent system is the total height of the vent. If the vent is too short, the draft will be very weak. In order for the gas to flow properly a large vent diameter will be required that offers minimal resistance. As the height of the vent system is increased, the draft becomes much stronger and a smaller vent diameter will prove to be adequate. This is an important cost consideration for the contractor. By increasing the height of the venting system a less expensive, smaller diameter vent may be used on the same BTU appliance.

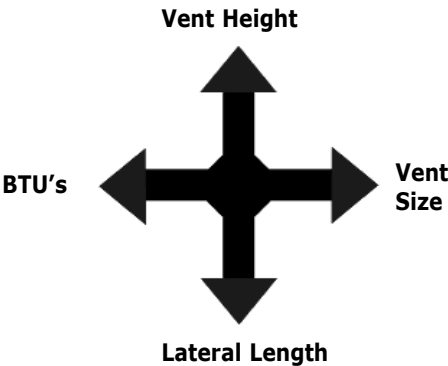
Locate the height column on the far left of Figure 45. Note that for any given vent diameter, the greater the height of the vent, the greater the BTU capacity of the venting system.

A third factor that determines the size of the vent is the length of any horizontal (lateral) runs. Since hot flue gas attempts to flow straight up, a lateral run of vent pipe serves as a restriction. This is also an important cost

consideration for the contractor. By eliminating long lateral runs in the venting system a less expensive, smaller diameter vent may be used on the same BTU appliance.

Locate the lateral column on the far left of Figure 45. Note that for any given vent diameter and height, the shorter the lateral run, the greater the BTU capacity of the venting system. The sizing table should be viewed as a basic tool for the design of venting systems that provides valuable information on how four key factors impact each other: the BTU rating of the appliance, the height of the vent, the length of any lateral runs, and the diameter of the vent. If any three factors are known, the sizing table will indicate what the fourth factor should be.

Figure 46.



For example, if the appliance input rating (BTU’s per hour), the height of the vent, and the length of the lateral run is known, the sizing table will indicate the proper vent diameter. On the far left hand side of the table, find the height of the vent and the length of the lateral run. Now, look across the table under the columns entitled NAT MAX to find a BTU capacity equal to or greater than the BTU input rating of the appliance. Now, look up at the top of that column to find the correct vent diameter.

The wise contractor will take advantage of these sizing tables to design a low cost, competitive bid. For example, the contractor can ask a series of questions, such as “What if I increased the height of the vent system, or reduced the length of the lateral run?” “Could I then use a less expensive, smaller common vent diameter vent?”

FAN-ASSISTED APPLIANCES

The sizing tables for fan-assisted appliances are very similar to the tables used for natural draft-appliances. Note in Figure 47 that the sizing table for fan-assisted appliances is

also dealing with the relationship between the vent diameter, height, lateral run, and appliance BTU’s. In fact, the only difference is a new column entitled FAN MIN/MAX.

Figure 47.

Height H (ft)	Lateral L (ft)	3"			4"		
		FAN min	NAT max	NAT max	FAN min	NAT max	NAT max
6	0	0	78	46	0	152	86
	2	13	51	36	18	97	67
	4	21	49	34	30	94	64
	6	25	46	32	36	91	61
8	0	0	84	50	0	165	94
	2	12	57	40	16	109	75
	5	23	53	38	32	103	71
	8	28	49	35	39	98	66

The purpose of the FAN MIN column is to determine if a sufficient amount of heat (BTU’s) is flowing into the vent in order to minimize condensation and also to quickly dry up any condensation that does form. This is very important for fan-assisted appliances which have a strong tendency to form highly corrosive condensation.

As the vent diameter increases in size, more heat is required to keep the vent dry. Note in Figure 47 that as the vent diameters increase in size, the FAN MIN BTU’s also increase.

For fan-assisted appliances, it is very important that the appliance BTU input rating falls between the FAN MIN and the FAN MAX. If the BTU input rating is less than the FAN MIN, condensation may occur. If the BTU input rating is greater than the FAN MAX, the flue gas may backup and cause the vent system to become pressurized.

SINGLE-WALL VS. DOUBLE-WALL CONNECTORS

A primary objective of the new sizing tables is to control the use of single-wall vent connectors. Since single-wall connectors permit a greater heat loss than double-wall air insulated vent connectors, it is very important to restrict the use of the single-wall connectors to only those installations where condensation is not expected to be a problem. In

many cases, the new sizing tables mandate the use of double-wall vent connectors.

In the past, only one set of sizing tables were provided that assumed the use of single-wall vent connectors. Today, two sets of tables exist; one set of tables for installations that utilize a single-wall connector, and a second set of tables for installations that utilize double-wall vent connectors. A comparison of the BTU values in the two sets of tables reveals only a small difference in the NAT MAX and FAN MAX BTU capacities. As expected, the maximum flow of gas primarily depends on the vent diameter, regardless of whether the vent is single-wall or double-wall.

Upon further examination of the tables, note that a major difference does exist between the FAN MIN capacity values. The minimum BTU capacity is significantly greater for single-wall vent connectors, as compared to the minimum BTU values listed for double-wall connectors. The reason for this difference is the greater heat loss with single-wall connectors, thus requiring a greater minimum heat input to insure that the vent will remain dry.

For fan-assisted appliances, the appliance input rating must fit between the FAN MIN and the FAN MAX. This is fairly easy to accomplish with the double-wall sizing tables due to the wide range between FAN MIN and FAN MAX. In contrast, the single-wall sizing tables may have a very tight range between the MIN and MAX capacities. In fact, the BTU range may be so tight that the appliance input rating cannot be fit into the MIN/MAX range. In some cases, the minimum BTU values may be so high that no range is left at all. When this occurs, the sizing table indicates “NR” for not recommended.

When it is no longer possible to fit between the FAN MIN and the FAN MAX or when the sizing table indicates “NR”, the contractor is forced to switch to the double-wall vent connector sizing table. In this manner, the new sizing tables frequently force the contractor to use double-wall, Type-B gas vent connectors.

SINGLE-WALL CONNECTOR TABLE

Note that for natural draft appliances the tables list a NAT MAX but no minimum BTU requirement. Since natural draft appliances have less tendency to form condensation, no minimum heat input is required by the tables. In most

cases the tables permit natural draft appliances to be installed using single-wall vent connectors. In many cases, fan-assisted appliances may also be installed with single-wall vent connectors. However, it is very important to check the sizing tables because, frequently, double-wall vent connectors will be required.

The wise contractor will evaluate the possibility of using low cost, single-wall vent connectors on fan-assisted appliances by designing a vent system that will fit into the FAN MIN/MAX range. To accomplish this goal, the contractor may wish to consider modifying the vent height, the length of a lateral run, or the diameter of the vent.

When faced with a borderline situation between single-wall and double-wall vent connectors, the Dura/Connect aluminum vent connector system provides for a cost effective, corrosion resistant solution. In fact, due to the very low corrosion resistance of single-wall galvanized steel vent connectors, combined with the tendency for modern gas appliances to be borderline condensing. Simpson Dura-Vent recommends that the aluminum flex Dura/Connect system be used whenever single-wall vent connectors are permitted.

COMMON VENT SYSTEMS

A common vent system refers to an installation of two or more gas appliances, installed on the same floor level, that are each connected to a common vent. The vent connector sizing tables for common vent installations are quite similar to the sizing tables for single appliance installations.

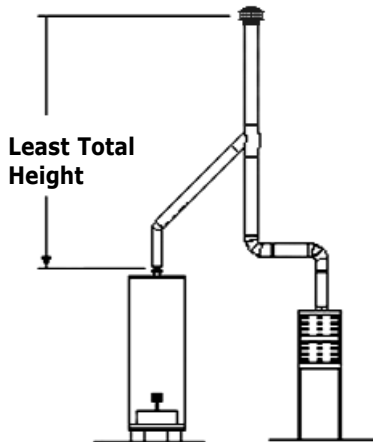
Figure 48.

Appliance Input Rating Limits in Thousands of BTU Per Hour

Vent Height (ft)	Connector Rise (ft)	3"			4"		
		min	FAN max	NAT max	min	FAN max	NAT max
6	1	22	37	26	35	66	46
	2	23	41	31	37	75	55
	3	24	44	35	38	81	62
8	1	22	40	27	35	72	48
	2	23	44	32	36	80	57
	3	24	47	36	37	87	64

There are two important differences when sizing vent connectors for common vented appliances. First, which

Figure 49.

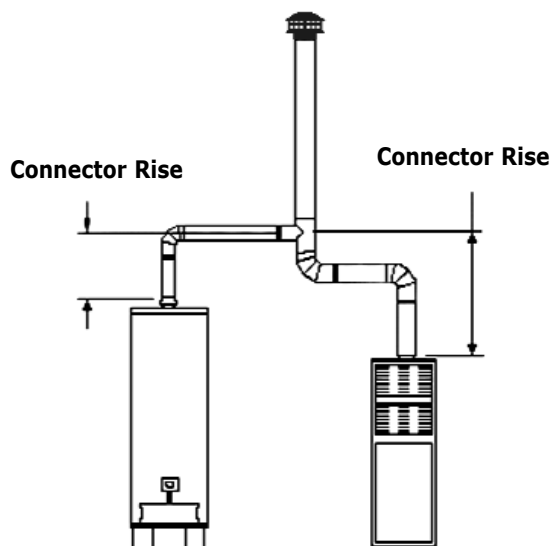


vent height is used when one appliance is taller than the other? To be on the conservative side, use the vent height measured from the taller appliance. Since the taller appliance will have the least total height, it is important to size the venting system to insure that the taller appliance will draft properly. Use the least total height when sizing vent connectors for both the tall and short appliances.

The second important difference in the vent connector tables for common vented appliances is the concern with the vertical height of the connector rise. This is the distance between the appliance flue outlet and the level at which the connector joins the common vent. This is important because the greater the connector rise, the stronger the draft.

The sample common vent sizing table (Figure 48) contains

Figure 50.



the “connector rise” column on the far left hand side of the table. Note that as the connector rise increases, the BTU capacity of the venting system also increases. When planning an installation, take advantage of a tall ceiling height by designing the vent system for maximum connector rise. This may permit a major reduction in the height of the vent, and in the cost of the installation.

For sizing the common vent, it is necessary to refer to the Common Vent Table. Note in Figure 51 that the common vent table is only concerned with the maximum BTU capacity for any given height and vent diameter. Since more than one appliance is connected to the common vent and it is possible that both appliances may be operating at the same time, it is necessary to add up all of the appliance BTU input ratings to arrive at the total BTU input to the common vent. It is also important to use the least total height value that was used in sizing the vent connectors.

Figure 51.

Combined Appliance input rating in thousands of BTU/Hour

Vent Height H (ft)	4"			5"		
	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT
6	NR	78	64	NR	113	99
8	NR	87	71	NR	126	111
10	NR	94	76	163	137	120
15	121	108	88	189	159	140
25	131	118	98	208	177	156
30	145	132	113	236	202	180

Note in Figure 51 that the common vent table lists three BTU columns for each vent diameter. “FAN + FAN”, “FAN + NAT”, and “NAT + NAT”. These column headings refer to the combination of appliances to be installed. Fan-assisted appliances provide a fan to “assist” the draft and have a lower volume of flue gas because no dilution air is introduced to the vent. As a result, combinations of appliances that include a fan-assisted unit have a greater BTU capacity than two natural draft appliances.

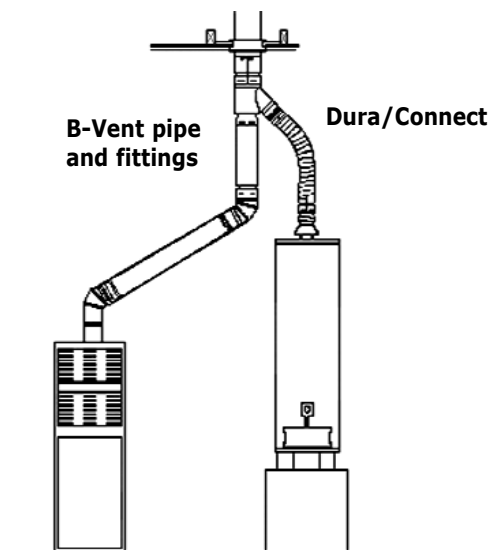
When common venting a fan-assisted appliance with a natural draft appliance, the MIN/MAX range in the common vent connector table may force the contractor to use a double-wall vent connector for the fan-assisted

appliance. In this case, a double-wall wye or tee must be used at the connection to the common vent. For the natural draft appliance, a single-wall vent connector may be used.

If a single-wall galvanized connector pipe is used on the natural draft appliance, it is important to check for any flue gas leakage that may develop at loose fitting, crimped joints and elbow gores. Some internal pressure may flow into the single-wall connector from the fan-assisted appliance. Simpson Dura-Vent recommends the use of the Dura/Connect flexible vent connector system that eliminates the use of elbows and provides for tight fitting, twist-lock connections.

It is very important to follow all of the rules and vent requirements for proper sizing. The sizing tables do not take into consideration many of the special circumstances that can significantly change the values listed in the tables. For example, the tables assume that only two 90° elbows are used in the entire vent system. When more than two 90° elbows are used, the maximum capacity values listed in the sizing tables must be reduced by 10% for each additional 90° elbow, or equivalent.

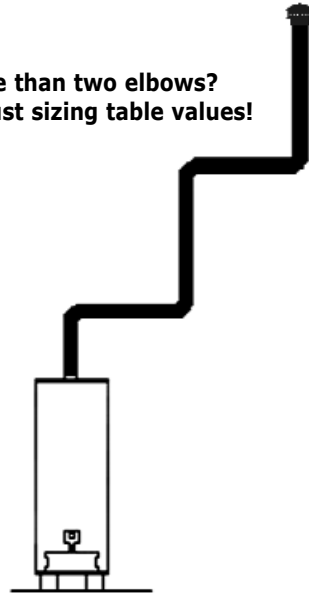
Figure 52.



In a similar manner, rules for special circumstances, such as, long lateral runs, common vent offsets, and vent size reductions, can modify the values listed in the sizing tables. Hopefully, these rules will not need to be used frequently, but it is important to become familiar with all of the rules, and to recognize situations where the rules need to be applied.

Figure 53.

**More than two elbows?
Adjust sizing table values!**



ALTERNATE SIZING METHOD

Prior to the introduction of fan-assisted gas appliances, installers typically relied on the “Alternate Sizing Method” for designing venting systems. The installer simply sized the vent to the size of the appliance flue outlet. While this method was very simple, it failed to take into account important factors such as the total height of the vent, length of lateral runs, number of elbows, etc. As a result, this sizing method often resulted in improperly sized installations and, in some cases, vent designs that could have been more cost effective.

Today, with the introduction of “near condensing” fan-assisted gas appliances and higher efficiency levels for draft hood-equipped appliances, proper sizing has become far more critical and less forgiving. The National Fuel Gas Code now restricts the use of the Alternate Sizing Method to Category I draft hood-equipped appliances only. Fan-assisted appliances must be sized using the vent tables.

The Alternate Sizing Method states:

1. “As an alternate method for sizing an individual gas vent for a single, draft hood-equipped appliance, the effective area of the vent connector and the gas vent shall be not less than the area of the appliance draft hood outlet.”
2. “As an alternate method for sizing gas vent connected to more than one draft hood-equipped appliance, the effective area of the vent shall be not less than the area of the largest vent connector plus 50% of the areas of

additional draft hood outlets.”

Simpson Dura-Vent does **not** recommend using the Alternate Sizing Method for the reasons stated above. If the Alternate Sizing Method is used, it should be strictly limited to draft hood-equipped appliances only, and limited to simple vent configurations which have very short lateral runs, tall vent heights, and few elbows, tees, or other restrictions.

Single Appliance Sizing Tables

DEFINITIONS

Single Appliance Vent: An independent vent for one appliance.

Total Vent Height (H): The vertical distance from the flue collar or draft hood outlet to the lowest discharge opening of the vent termination.

Lateral (L): The horizontal distance or length of offset between the appliance outlet and the entry to the vertical vent.

TABLE HEADINGS:

FAN: Applies to Category I fan-assisted combustion appliances.

NAT: Applies to natural draft appliances equipped with a draft hood or draft diverter.

MIN: The minimum BTU heat input required in order to prevent condensation.

MAX: The highest BTU input allowed without causing draft hood spillage on natural draft appliances or positive pressure in vents on fan-assisted appliances.

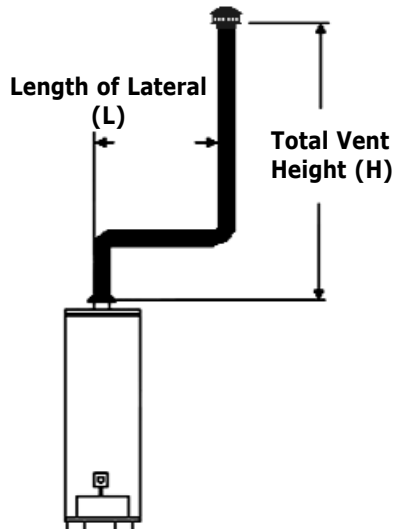
NR: Not recommended due to potential for condensate formation and/or pressurization of the venting system.

HOW TO USE THE SINGLE APPLIANCE VENT TABLE

To determine the proper vent size for a single appliance vent, use the Single Appliance Vent Tables as follows:

1. When using Type-B gas vent as the vent connector, select the Single Appliance Vent Table I. If single-wall vent connectors are used, select the Single Appliance Vent Table II.
2. Determine the Total Vent Height and length of lateral as shown in figure 54.

Figure 54.



3. In the Height (H) column at the far left of the table find a height equal to or less than the total height of the installation.

4. Select the horizontal row for the appropriate Lateral (L) length equal to or greater than the lateral length determined for the appliance installation. (For straight vertical vents, use zero as the lateral length.)

5. For natural draft appliances, read across to the first column under NAT Max, which has a BTU capacity equal to or greater than the nameplate sea level input rating of the appliance. The proper vent size is shown at the top of the column.

6. For fan-assisted appliances, read across to the first column under FAN Min/Max which has a Min value less than or equal to the appliance input rating, and a Max value greater than or equal to the appliance input rating. The appliance input rating must fit within the Min and Max limits. The proper vent size is shown at the top of the column.

NOTE:

A. If Table II (single-wall connectors) does not permit the appliance input rating to fit into a FAN Min/Max range or the table shows an "NR" (not recommended), the tables require the use of Type-B gas vent as the vent connector. Switch to Table I.

B. If the vent size shown by the table is smaller than the appliance outlet size, it is important to refer to the rules for vent sizes less than the appliance outlet size.

VENT SIZES LESS THAN THE APPLIANCE OUTLET SIZE

If the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the smaller size may be used provided:

- A. The total vent height (H) is at least 10 feet.
- B. Vents or connectors for appliance draft hood outlets or flue collars 12 inches in diameter or smaller are not reduced more than one size (i.e., 12 inch to 10 inch is a one size reduction).
- C. Vents or connectors for appliance draft hood or flue collars above 12 inch in diameter are not reduced more than two table sizes (i.e., 24 inch to 20 inch, is a two size reduction).
- D. The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10% ($0.90 \times$ maximum capacity).
- E. The draft hood outlet is greater than 4 inch in diameter. Do not connect a 3 inch diameter vent or connector to a 4 inch diameter draft hood outlet. This provision does not apply to fan-assisted appliances.

COMPENSATING FOR EXTRA ELBOWS

For single appliance venting configurations, Tables I and II, a zero lateral length is assumed to have no elbows in the vent system. For vent configurations that do have lateral lengths, the capacities shown in the tables assume that the vent system has the equivalent of two 90° elbows, which may be located at any position in the vent system. The system could have:

- A. Two 90° elbows.
- B. One 90° elbow and one tee.
- C. Four 45° elbows.
- D. Two 45° elbows and one tee.

When more than two 90° elbows are required in the venting system, the maximum capacity listed in the venting tables should be reduced by 10% ($0.90 \times$ maximum listed capacity) for each additional 90° elbow, or equivalent. Please note that 90° elbows are only allowed in the same space as the appliance and are not permitted above the ceiling.

Figure 55.



If a second offset is required in the venting system, it would be better to use two 45° elbows (10% reduction in capacity) to accomplish the offset, as compared to two 90° elbows (20% reduction in maximum capacity). See Figure 55.

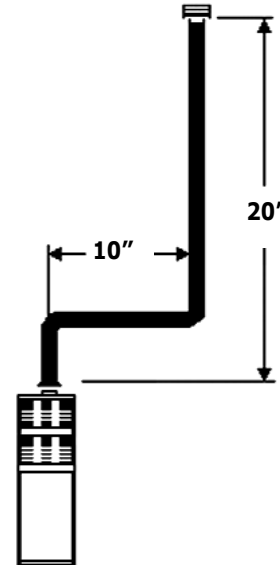
SIZING EXAMPLES

A typical natural draft appliance venting example is shown in Figure 56. The appliance has an input rating of 140,000 BTU per hour and a 6-inch draft hood outlet. The installation has a Total Vent Height of 20 feet, with a 10-foot lateral.

Procedure:

1. Refer to the Single Appliance Vent Table I.
2. Go down the Total Height (H) column to the 20-foot line. Go across on the 10-foot Lateral (L) line.
3. Find a NAT Max column with a BTU capacity equal to or greater than the BTU capacity of the appliance. A 150,000 BTU maximum capacity is found in the 5-inch vent size column. Since this is greater than our 140,000 BTU appliance, a 5-inch vent size is correct.
4. A 5-inch vent size is adequate, even though the appliance has a 6-inch draft hood outlet, because the total height exceeds 10 feet. (See rules on down sizing.)

Figure 56.



A typical fan-assisted appliance installation can be illustrated by Figure 56. Assume the appliance has the same 140,000 BTU rating, a 20 foot vent height and a 10 foot lateral run.

Procedure:

1. Refer to the Single Appliance Vent Table I.
2. Go down the Height (H) column to 20 feet, then go across on the 10 foot lateral line.
3. Find the correct FAN Min/Max column for the 140,000 BTU appliance. The 5 inch vent column is found to have a FAN Min capacity of 50,000 BTU's and a FAN Max capacity of 229,000 BTU's. The 140,000 BTU appliance fits into the 5 inch column MIN/ MAX range.
4. A 5 inch vent size is adequate, even though the appliance has a 6 inch flue collar, because the total vent height is greater than 10 feet.

Note: The contractor could have referred to the Single Appliance Vent Table II which is used for single-wall vent connectors. A 5 inch vent size would also be selected. Note that the MIN/ MAX range is much tighter (125,000 - 223,000) but the 140,000 BTU appliance does fit into the restricted range.

IN-BETWEEN HEIGHTS AND LATERALS (INTERPOLATION)

It is possible to select heights or laterals which are between the values listed in the tables. Not only will this result in a more accurate vent size, but in some cases, you can avoid having to go to the next larger vent diameter.

A typical example of use of the tables for in-between heights is shown in Figure 57. The natural draft furnace has an input rating of 80,000 BTU per hour and is equipped with a 4-inch draft hood outlet. The Total Vent Height is 12 1/2 feet, with a 5 foot lateral.

Procedure:

1. Refer to the Single Appliance Vent Table I (Type-B connectors).
2. Go down the Height (H) column to a height that is equal to, or less than, the total vent height of the installation, which would be 10 feet.
3. Under 4 inch vent size, a 5 foot lateral shows a NAT Max BTU capacity of 77,000 BTU which is too small for the 80,000 BTU appliance. A 5 inch vent size (124,000 BTU Max) is required.
4. Note the 12 1/2-foot height of the installation is halfway between the 10 foot height and the 15 foot heights listed in the table. The maximum capacities in the table for a 4 inch vent with a 5 foot lateral are:

15-foot height = 87,000 BTU

10-foot height = 77,000 BTU

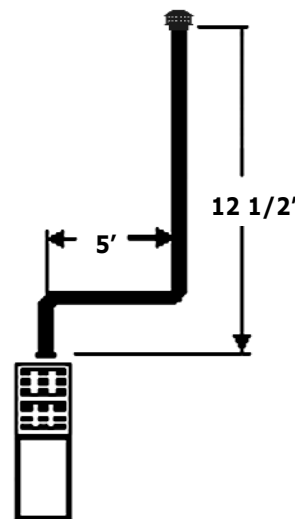
The difference 10,000 BTU

The 12 1/2-foot height is halfway between the 10-foot and 15-foot heights listed in the tables, we take 1/2 of the difference ($1/2 \times 10,000 = 5,000$) and add it to 77,000. The result is 82,000. Since our appliance has a BTU rating of 80,000, this means a 4-inch vent may be used for this application instead of the 5-inch size which was required before checking the in-between height.

This procedure of interpolating between heights may also be used to estimate in-between lateral lengths and in-between minimum capacities.

WARNING: It is not possible to interpolate between zero laterals (straight vertical vent) and a 2-foot lateral because

Figure 57.



the capacities listed for 2-foot laterals have assumed the use of two 90° elbows. For vent installations with just one 90° turn, assume a 2-foot lateral.

ALTERNATE SIZING METHOD

The National Fuel Gas Code now restricts the use of the Alternate Sizing Method to Category I draft hood-equipped appliances only. Fan-assisted appliances must be sized using the vent tables.

The Alternate Sizing Method states:

“As an alternate method for sizing an individual gas vent for a single, draft hood-equipped appliance, the effective area of the vent connector and the gas vent shall be not less than the area of the appliance draft hood outlet.”

Simpson Dura-Vent does **not recommend** using the Alternate Sizing Method. If the Alternate Sizing Method is used, it should be strictly limited to draft hood-equipped appliances only and limited to simple vent configurations which have very short lateral runs, tall vent heights, and few elbows, tees, or other restrictions.

TABLE 1

**Capacity of TYPE B DOUBLE-WALL VENTS with
TYPE B DOUBLE-WALL CONNECTORS**

Serving a Single Category I Appliance

Appliance Input Rating in Thousands of BTU per hour

Height H (ft)	Lateral L (ft)	3"			4"			5"			6"			7"			8"			10"		
		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	1121	570
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	75	675	455
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	110	668	445
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205	93	413	273	128	661	435
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1261	660
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	71	770	515
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	115	758	503
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	137	746	490
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1377	720
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	68	852	560
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	112	839	547
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	142	817	525
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1596	840
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	63	1019	675
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	105	1003	660
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	135	977	635
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	155	953	610
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430	0	1057	575	0	1756	930
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	531	346	41	711	470	59	1150	755
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460	101	1133	738
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443	130	1105	710
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308	111	654	427	150	1078	688
	20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295	125	634	410	167	1052	665
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475	0	1173	650	0	1977	1060
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	54	1351	865
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524	96	1332	851
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	125	1301	829
	15	33	64	NR	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	143	1272	807
	20	56	58	NR	53	132	90	66	237	154	80	374	237	102	542	343	119	743	473	160	1243	784
	30	NR	NR	NR	73	113	NR	88	214	NR	104	346	219	131	507	321	149	702	444	195	1189	745
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518	0	1297	708	0	2231	1195
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	41	1620	1010
	5	20	82	NR	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	90	1600	996
	10	26	76	NR	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	118	1567	972
	15	59	70	NR	42	158	NR	54	287	180	66	455	288	85	662	413	100	911	572	136	1536	948
	20	NR	NR	NR	50	149	NR	63	275	169	76	440	278	97	642	401	113	888	556	151	1505	924
	30	NR	NR	NR	69	131	NR	84	250	NR	99	410	259	123	605	376	141	844	522	183	1446	876
100	0	NR	NR	NR	0	218	NR	0	407	NR	0	665	400	0	997	560	0	1411	770	0	2491	1310
	2	NR	NR	NR	10	194	NR	12	354	NR	13	566	375	18	831	510	21	1155	700	30	1975	1170
	5	NR	NR	NR	26	189	NR	33	347	NR	40	557	369	52	820	504	60	1141	692	82	1955	1159
	10	NR	NR	NR	33	182	NR	43	335	NR	53	542	361	68	801	493	80	1118	679	108	1923	1142
	15	NR	NR	NR	40	174	NR	50	321	NR	62	528	353	80	782	482	93	1095	666	126	1892	1124
	20	NR	NR	NR	47	166	NR	59	311	NR	71	513	344	90	763	471	105	1073	653	141	1861	1107
	30	NR	NR	NR	NR	NR	NR	78	290	NR	92	483	NR	115	726	449	131	1029	627	170	1802	1071
	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	147	428	NR	180	651	405	197	944	575	241	1688	1000

TABLE 1

**Capacity of TYPE B DOUBLE-WALL VENTS with
TYPE B DOUBLE-WALL CONNECTORS**

Serving a Single Category I Appliance

Appliance Input Rating in Thousands of BTU per hour

Height Lateral		12"			14"			16"			18"			20"			22"			24"		
H (ft)	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	1645	850	0	2267	1170	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	103	982	650	138	1346	890	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	147	975	640	191	1338	880	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	171	967	630	219	1330	870	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	1858	970	0	2571	1320	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010
	2	98	1124	745	130	1543	1020	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	154	1110	733	199	1528	1010	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	180	1097	720	231	1514	1000	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	2036	1060	0	2825	1450	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	93	1244	850	124	1713	1130	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	149	1229	829	192	1696	1105	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371
	10	187	1204	795	238	1669	1080	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	2380	1240	0	3323	1720	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10393	5300
	2	86	1495	985	114	2062	1350	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080
	5	140	1476	967	182	2041	1327	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	177	1446	936	227	2009	1289	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
	15	202	1418	905	257	1976	1250	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980
20	0	0	2637	1350	0	3701	1900	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11753	6000
	2	81	1694	1100	107	2343	1520	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	135	1674	1079	174	2320	1498	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	172	1641	1045	220	2282	1460	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
	15	195	1609	1018	248	2245	1425	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575
	20	217	1578	990	273	2210	1390	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550
30	0	0	3004	1550	0	4252	2170	0	5725	2920	0	7420	3770	0	9341	4750	0	11483	5850	0	13848	7060
	2	74	2004	1310	98	2786	1800	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600
	5	127	1981	1289	164	2759	1775	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5552
	10	164	1944	1254	209	2716	1733	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471
	15	187	1908	1220	237	2674	1692	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391
	20	207	1873	1185	260	2633	1650	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310
	30	246	1807	1130	305	2555	1585	369	3433	2130	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225
50	0	0	3441	1825	0	4934	2550	0	6711	3440	0	8774	4460	0	11129	5635	0	13767	6940	0	16694	8430
	2	66	2431	1513	86	3409	2125	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10788	6860
	5	118	2406	1495	151	3380	2102	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10737	6818
	10	154	2366	1466	196	3332	2064	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10652	6749
	15	177	2327	1437	222	3285	2026	274	4409	2721	330	5701	3534	396	7155	4511	465	8779	5546	542	10570	6710
	20	195	2288	1408	244	3239	1987	300	4356	2675	361	5641	3481	433	7086	4479	506	8704	5506	586	10488	6670
	30	232	2214	1349	287	3150	1910	347	4253	2631	412	5523	3431	494	6953	4421	577	8557	5444	672	10328	6603
100	0	0	3925	2050	0	5729	2950	0	7914	4050	0	10485	5300	0	13454	6700	0	16817	8600	0	20578	10300
	2	44	3027	1820	72	4313	2550	95	5834	3500	120	7591	4600	138	9577	5800	169	11803	7200	204	14264	8800
	5	107	3002	1803	136	4282	2531	172	5797	3475	208	7548	4566	245	9528	5769	293	11748	7162	341	14204	8756
	10	142	2961	1775	180	4231	2500	223	5737	3434	268	7478	4509	318	9447	5717	374	11658	7100	436	14105	8683
	15	163	2920	1747	206	4182	2469	252	5678	3392	304	7409	4451	358	9367	5665	418	11569	7037	487	14007	8610
	20	181	2880	1719	226	4133	2438	277	5619	3351	330	7341	4394	387	9289	5613	452	11482	6975	523	13910	8537
	30	215	2803	1663	265	4037	2375	319	5505	3267	378	7209	4279	446	9136	5509	514	11310	6850	592	13720	8391
	50	292	2657	1550	350	3856	2250	415	5289	3100	486	6956	4050	572	8841	5300	659	10979	6600	752	13354	8100

TABLE 2

**Capacity of TYPE B DOUBLE-WALL VENTS with
SINGLE-WALL METAL CONNECTORS**

Serving a Single Category I Appliance

Appliance Input Rating in Thousands of BTU per hour

Height H	Lateral L	3"			4"			5"			6"			7"			8"			10"			12"		
		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT	
(ft)	(ft)	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284	211	695	369	371	1118	569	537	1639	849
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213	201	423	284	347	673	453	498	979	648
	4	NR	NR	33	74	92	63	102	152	102	146	225	152	187	313	208	237	416	277	409	664	443	584	971	638
	6	NR	NR	31	83	89	60	114	147	99	163	220	148	207	307	203	263	409	271	449	656	433	638	962	627
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414	360	1257	658	521	1852	967
	2	39	56	39	59	108	75	83	176	119	121	261	179	155	363	246	197	482	321	339	768	513	486	1120	743
	5	NR	NR	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311	418	754	500	598	1104	730
	8	NR	NR	33	90	95	64	122	161	107	175	243	163	223	342	225	280	458	300	470	740	486	665	1089	715
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	202	844	449	351	1373	718	507	2031	1057
	2	39	61	41	59	117	80	82	193	128	119	287	194	153	400	272	193	531	354	332	849	559	475	1242	848
	5	52	56	39	76	111	76	105	185	122	148	277	186	190	388	261	241	518	344	409	834	544	584	1224	825
	10	NR	NR	34	97	100	68	132	171	112	188	261	171	237	369	241	296	497	325	492	808	520	688	1194	788
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388	195	966	523	336	1591	838	488	2374	1237
	2	38	69	47	57	136	93	80	225	149	115	337	224	148	473	314	187	631	413	319	1015	673	457	1491	983
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	231	616	400	392	997	657	562	1469	963
	10	NR	NR	39	95	116	79	128	201	131	182	308	203	228	438	284	284	592	381	470	966	628	664	1433	928
	15	NR	NR	NR	NR	NR	72	158	186	124	220	290	192	272	418	269	334	568	367	540	937	601	750	1399	894
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	190	1053	573	326	1751	927	473	2631	1346
	2	37	74	50	56	148	99	78	248	165	113	375	248	178	528	344	182	708	468	309	1146	754	443	1689	1098
	5	50	68	47	73	140	94	100	239	158	141	363	239	187	514	334	224	692	457	381	1126	734	547	1665	1074
	10	NR	NR	41	93	129	86	125	223	146	177	344	224	222	491	316	277	666	437	457	1092	702	646	1626	1037
	15	NR	NR	NR	NR	NR	80	155	208	136	216	325	210	264	469	301	325	640	419	526	1060	677	730	1587	1005
	20	NR	NR	NR	NR	NR	NR	186	192	126	254	306	196	309	448	285	374	616	400	592	1028	651	808	1550	973
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	184	1168	647	312	1971	1056	454	2996	1545
	2	37	80	56	55	164	111	76	281	183	109	429	279	139	610	392	175	823	533	296	1346	863	424	1999	1308
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382	215	806	521	366	1324	846	524	1971	1283
	10	NR	NR	NR	91	144	98	122	255	168	171	397	257	213	570	367	265	777	501	440	1287	821	620	1927	1243
	15	NR	NR	NR	115	131	NR	151	239	157	208	377	242	255	547	349	312	750	481	507	1251	794	702	1884	1205
	20	NR	NR	NR	NR	NR	NR	181	223	NR	246	357	228	298	524	333	360	723	461	570	1216	768	780	1841	1166
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	389	477	305	461	670	426	704	1147	720	937	1759	1101
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	295	2223	1189	428	3432	1818
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	280	1615	1007	401	2426	1509
	5	48	80	NR	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	347	1591	991	496	2396	1490
	10	NR	NR	NR	89	160	NR	118	292	186	162	461	292	203	671	420	253	923	583	418	1551	963	589	2347	1455
	15	NR	NR	NR	112	148	NR	145	275	174	199	441	280	244	646	405	299	894	562	481	1512	934	668	2299	1421
	20	NR	NR	NR	NR	NR	NR	176	257	NR	236	420	267	285	622	389	345	866	543	544	1473	906	741	2251	1387
	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	315	376	NR	373	573	NR	442	809	502	674	1399	848	892	2159	1318
100	0	NR	NR	NR	49	214	NR	69	403	NR	100	659	395	131	991	555	166	1404	765	273	2479	1300	395	3912	2042
	2	NR	NR	NR	51	192	NR	70	351	NR	98	563	373	125	828	508	158	1152	698	259	1970	1168	371	3021	1817
	5	NR	NR	NR	67	186	NR	90	342	NR	125	551	366	156	813	501	194	1134	688	322	1945	1153	460	2990	1796
	10	NR	NR	NR	85	175	NR	113	324	NR	153	532	354	191	789	486	238	1104	672	389	1905	1133	547	2938	1763
	15	NR	NR	NR	132	162	NR	138	310	NR	188	511	343	230	764	473	281	1075	656	447	1865	1110	618	2888	1730
	20	NR	NR	NR	NR	NR	NR	168	295	NR	224	487	NR	270	739	458	325	1046	639	507	1825	1087	690	2838	1696
	30	NR	NR	NR	NR	NR	NR	231	264	NR	301	448	NR	355	685	NR	418	988	NR	631	1747	1041	834	2739	1627
	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	540	584	NR	617	866	NR	895	1591	NR	1138	2547	1489

Multiple Appliances Sizing Tables

DEFINITIONS FOR MULTIPLE APPLIANCE VENTS

Multiple Appliance Vent: A venting system which combines the connectors of two or more appliances at one floor level, attached to a common vent.

Common Vent: A vent which serves two or more appliances that are installed on the same floor level.

Vent Connector: The vent piping that connects the outlet of the appliance to the junction member of the common vent.

Least Total Height: The vertical distance from the highest appliance outlet (draft hood or flue collar) in the system to the lowest discharge opening of the vent top.

Connector Rise: The vertical distance from the appliance outlet to the level at which the connector joins the common vent.

Figure 58.

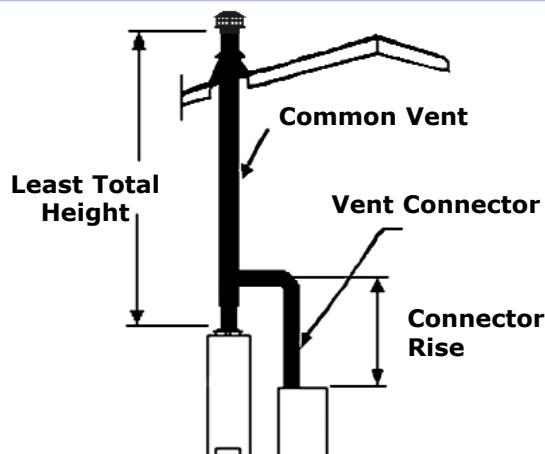


TABLE HEADINGS:

FAN + FAN: Refers to the maximum combined input rating of two or more fan-assisted appliances attached to the common vent.

FAN + NAT: Refers to the maximum combined input rating of one or more fan-assisted appliances and one or more draft hood-equipped appliances attached to the common vent.

NAT+ NAT: Refers to the maximum combined input rating of two or more draft hood equipped appliances attached to the common vent.

NR: Not recommended due to potential for condensate formation and/or pressurization of the venting system.

HOW TO USE THE MULTIPLE APPLIANCE VENTING TABLES:

HOW TO DETERMINE EACH CONNECTOR SIZE

Procedure:

1. Determine the Least Total Height for the system.
2. Determine the Connector Rise for each appliance.
3. Read down the Least Total Height (H) column at the far left of the table to find a height equal to or less than the least total height of the installation.
4. Select the horizontal row for the Connector Rise equal to or less than the rise determined for each appliance.
5. For natural draft appliances, read across to the first column under NAT Max, which has a BTU capacity greater than or equal to the nameplate sea level input rating of the appliance to be vented. The proper vent connector size is shown at the top of the column.
6. For fan-assisted appliances, read across to the first column under FAN Min/Max which has a Min less than or equal to the appliance input rating and a Max greater than or equal to the appliance input rating. The appliance input rating must fit within the Min and

Max limits. The proper vent connector size is shown at the top of the column.

NOTE:

A. If Table IV (single-wall connectors) does not permit the appliance input rating to fit into a FAN Min/Max range or the table shows an NR (not recommended), the tables require the use of Type-B gas vent as the vent connector. Switch to Table III.

B. If the vent size shown by the table is smaller than the appliance outlet size, refer to the rules for vent sizes less than the appliance outlet size.

PROCEDURE TO DETERMINE THE COMMON VENT SIZE

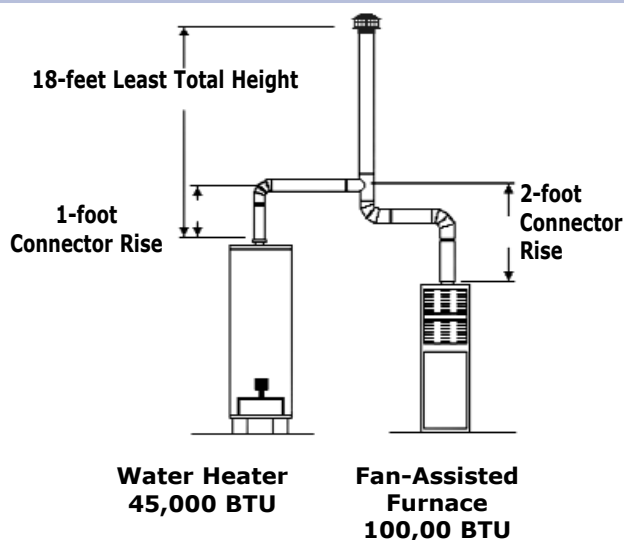
Procedure:

1. Add up the appliance BTU input ratings for all appliances to get the Total BTU Input.
2. If one or more connectors used in the system are single-wall, use Table IV for sizing the common vent. If all connectors are Type-B gas vent, use Table III for sizing the common vent.
3. Read down the Least Total Height column of the common vent table to find a height equal to or less than the same **Least Total Height** used for connectors.
4. Read across the table to the first column of maximum BTU capacities that is equal to, or greater than, the Total BTU Input of the appliances to be common vented. Be sure to select the appropriate column for the type of appliances to be installed (i.e., FAN+FAN for two fan-assisted appliances).
5. If Table IV for the common vent indicates an NR (not recommended), the entire system including all connectors, as well as the common vent, should be installed with Type-B gas vent. Switch to Table II.
6. Regardless of the results obtained from the sizing table, under no circumstances should the common vent be smaller than the largest connector. If both connectors are the same size, the common vent must be at least one size larger.

SIZING EXAMPLES

Figure 59 is an example of a typical common vent system, consisting of a draft hood equipped water heater, and a fan-assisted Category I furnace. Design the vent system for the 45,000 BTU water heater with a 1-foot connector rise, and the 100,000 BTU fan-assisted furnace with a 2-foot connector rise, to a common vent with a "least total height" of 18 feet.

Figure 59.



STEP #1 -

DETERMINE WATER HEATER VENT CONNECTOR SIZE.

Procedure:

1. Refer to Vent Connector Table III for Type B double-wall connectors or Table IV for single-wall connectors. In this example, we will select Table IV.
2. Read down the Least Total Height column to a height equal to or less than the 18-foot Least Total Height of the installation. We, therefore, select the 15-foot height.
3. Read across the 1-foot connector rise line to a BTU capacity equal to, or greater than, the 45,000 BTU water heater input rating. The table shows a 52,000 BTU capacity for a 4-inch single-wall vent connector.
4. Since 52,000 BTU's is in excess of the water heater

input, it is not necessary to find the maximum input for an 18-foot Least Total Height. Use a 4-inch vent connector, even if the water heater draft hood outlet is 3 inches.

STEP #2 -

DETERMINE FURNACE VENT CONNECTOR SIZE.

Procedure:

1. Suppose we first try out a single-wall connector to the 100,000 BTU fan-assisted furnace. Refer to Vent Connector Table IV.
2. Enter Table IV at a height equal to or less than the 18-foot Least Total Height. We, therefore, select the 15-foot height and a 2-foot connector rise.
3. Read across the 2-foot connector rise line to a FAN Min/Max range that can accommodate the 100,000 BTU appliance. We find that the maximum BTU's in the 4-inch vent column is only 94,000 so we cannot use a 4-inch vent. We also find that the minimum BTU's under the 5-inch vent column is 121,000 BTU's, so we cannot fit into the MIN/MAX range for 5-inch vents. The result is we cannot use a single-wall vent connector and must switch to Table III.
4. Enter Table III at the 15-foot height and 2-foot connector rise. Read across the 2-foot connector rise line to the first FAN Min/Max range that can accommodate the 100,000 BTU appliance. Under the 5-inch vent connector column, we find that the FAN Min is 49,000 BTU and the FAN Max is 153,000 BTU. The 100,000 BTU appliance fits into this MIN/MAX range. Therefore, 5-inch is the correct vent connector size and the connector must be Type B gas vent.

STEP #3 -

DETERMINE THE COMMON VENT SIZE.

Procedure:

1. Since one of the connectors is single-wall, refer to the Common Vent Table IV.
2. Add the BTU input ratings for both appliances

(100,000 + 45,000 = 145,000) to determine the combined appliance input rating.

3. Enter the table at a vent height less than, or equal to, the Least Total Height. Enter the table at 15 feet.
4. Read across the table to the first FAN + NAT BTU capacity which is equal to, or greater than the 145,000 combined capacity, of both appliances. Under the 5-inch column, we find a maximum capacity of 159,000 BTU's, so the correct common vent size is 5 inches.
5. Since the actual Least Total Height of our installation is 18 feet, we could do some math and interpolate to see if a 4-inch common vent would be possible. However, by simply looking at the table, we see that a 20-foot height has a maximum 118,000 BTU's for a 4-inch vent, which is less than our 145,000 requirement. Since an 18-foot height would have an even lower maximum BTU capacity than a 20-foot height, we know that there is no point in doing the math. A 5-inch common vent is the smallest common vent possible.

ALTERNATE SIZING METHOD

The National Fuel Gas Code now restricts the use of the Alternate Sizing Method to Category I draft hood- (i.e., natural draft) equipped appliances only. Fan-assisted appliances must be sized using the vent tables.

The Alternative Sizing Method States:

“As an alternate method for sizing a gas vent connected to more than one draft hood-equipped appliance, the effective area of the vent shall be not less than the area of the largest vent connector plus 50% of the areas of additional draft hood outlets.”

Simpson Dura-Vent does not recommend using the Alternate Sizing Method. If the Alternate Sizing Method is used, it should be strictly limited to draft hood-equipped appliances only and limited to simple vent configurations which have very short lateral runs, tall vent heights, and no elbows in the common vent.

TABLE 3

**Capacity of TYPE B DOUBLE-WALL VENTS with
TYPE B DOUBLE-WALL CONNECTORS**

Serving two or more Category I Appliances

Appliance Input Rating in Thousands of BTU per hour

Vent Connector		3"			4"			5"			6"			7"			8"			10"		
Height Rise (ft) (ft)		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142	92	296	185	128	466	289
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168	95	333	220	131	526	345
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189	97	363	248	134	575	386
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148	100	320	194	138	507	303
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175	103	356	230	141	564	358
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	143	612	402
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154	106	341	200	146	542	314
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182	109	374	238	149	596	372
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205	111	402	268	152	642	417
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163	110	389	214	162	609	333
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193	112	419	253	165	658	394
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218	115	445	286	167	700	444
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171	107	436	224	158	681	347
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202	110	463	265	161	725	414
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228	113	486	300	164	764	466
30	1	20	62	33	31	113	59	45	181	93	60	288	134	83	391	182	103	512	238	151	802	372
	2	21	64	39	33	118	70	47	190	110	62	299	158	85	408	215	105	535	282	155	840	439
	3	22	66	44	34	123	79	48	198	124	64	309	178	88	423	242	108	555	317	158	874	494
50	1	19	71	36	30	133	64	43	216	101	57	349	145	78	477	197	97	627	257	144	984	403
	2	21	73	43	32	137	76	45	223	119	59	358	172	81	490	234	100	645	306	148	1014	478
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263	103	661	343	151	1043	538
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204	91	810	266	135	1285	417
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242	94	822	316	139	1306	494
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272	97	834	355	142	1327	555

Serving two or more Category I Appliances

Combined Appliance Input Rating in Thousands of BTU per hour

Common Vent Diameter

Vent		4"			5"			6"			7"			8"			10"		
Height FT		FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT
6		92	81	65	140	116	103	204	161	147	309	248	200	404	314	260	672	520	410
8		101	90	73	155	129	114	224	178	163	339	275	223	444	348	290	740	577	465
10		110	97	79	169	141	124	243	194	178	367	299	242	477	377	315	800	627	495
15		125	112	91	195	164	144	283	228	206	427	352	280	556	444	365	924	733	565
20		136	123	102	215	183	160	314	255	229	475	394	310	621	499	405	1035	826	640
30		152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	1209	975	740
50		167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1451	1188	860
100		175	163	NR	311	277	NR	489	421	NR	751	658	479	1025	873	625	1784	1502	975

TABLE 3

**Capacity of TYPE B DOUBLE-WALL VENTS with
TYPE B DOUBLE-WALL CONNECTORS**

Serving two or more Category I Appliances

Appliance Input Rating in Thousands of BTU per hour

Vent Connector Diameter

Height Lateral		12"			14"			16"			18"			20"			22"			24"		
H (ft)	L (ft)	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		min	max	max	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max	min	max	max
6	2	174	764	496	223	1046	653	281	1371	853	346	1772	1080	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	180	897	616	230	1231	827	287	1617	1081	352	2069	1370	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	2	186	822	516	238	1126	696	298	1478	910	365	1920	1150	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	192	952	644	244	1307	884	305	1719	1150	372	2211	1460	471	2737	1800	560	3319	2180	662	3957	2590
	6	198	1050	772	252	1445	1072	313	1902	1390	380	2434	1770	478	3018	2180	568	3665	2640	669	4373	3130
10	2	196	870	536	249	1195	730	311	1570	955	379	2049	1205	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	201	997	664	256	1371	924	318	1804	1205	387	2332	1535	486	2887	1890	581	3502	2280	686	4175	2710
	6	207	1095	792	263	1509	1118	325	1989	1455	395	2556	1865	494	3169	2290	589	3849	2760	694	4593	3270
15	2	214	967	568	272	1334	790	336	1760	1030	408	2317	1305	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	221	1085	712	279	1499	1006	344	1978	1320	416	2579	1665	523	3197	2060	624	3881	2490	734	4631	2960
	6	228	1181	856	286	1632	1222	351	2157	1610	424	2796	2025	533	3470	2510	634	4216	3030	743	5035	3600
20	2	223	1051	596	291	1443	840	357	1911	1095	430	2533	1385	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	230	1162	748	298	1597	1064	365	2116	1395	438	2778	1765	554	3447	2180	661	4190	2630	772	5005	3130
	6	237	1253	900	307	1726	1288	373	2287	1695	450	2984	2145	567	3708	2650	671	4511	3190	785	5392	3790
30	2	216	1217	632	286	1664	910	367	2183	1190	461	2891	1540	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	223	1316	792	294	1802	1160	376	2366	1510	474	3110	1920	619	3840	2365	728	4681	2860	847	5606	3410
	6	231	1400	952	303	1920	1410	384	2524	1830	485	3299	2340	632	4080	2875	741	4976	3480	860	5961	4150
50	2	206	1479	689	273	2023	1007	350	2659	1315	435	3548	1665	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	213	1561	860	281	2139	1291	359	2814	1685	447	3730	2135	580	4601	2633	709	5569	3185	851	6633	3790
	6	221	1631	1031	290	2242	1575	369	2951	2055	461	3893	2605	594	4808	3208	724	5826	3885	867	6943	4620
100	2	192	1923	712	254	2644	1050	326	3490	1370	402	4707	1740	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	200	1984	888	263	2731	1346	336	3606	1760	414	4842	2220	523	5982	2750	639	7254	3330	769	8650	3950
	6	208	2035	1064	272	2811	1642	346	3714	2150	426	4968	2700	539	6143	3350	654	7453	4070	786	8892	4810

Serving two or more Category I Appliances

Combined Appliance Input Rating in Thousands of BTU per hour

Common Vent Diameter

Vent	12"			14"			16"			18"			20"			22"			24"		
Height FT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT
6	900	696	588	1284	990	815	1735	1336	1065	2253	1732	1345	2838	2180	1660	3488	2677	1970	4206	3226	2390
8	994	773	652	1423	1103	912	1927	1491	1190	2507	1936	1510	3162	2439	1860	3890	2998	2200	4695	3616	2680
10	1076	841	712	1542	1200	995	2093	1625	1300	2727	2113	1645	3444	2665	2030	4241	3278	2400	5123	3957	2920
15	1247	986	825	1794	1410	1158	2440	1910	1510	3184	2484	1910	4026	3133	2360	4971	3862	2790	6016	4670	3400
20	1405	1116	916	2006	1588	1290	2722	2147	1690	3561	2798	2140	4548	3552	2640	5573	4352	3120	6749	5261	3800
30	1658	1327	1025	2373	1892	1525	3220	2558	1990	4197	3326	2520	5303	4193	3110	6539	5157	3680	7940	6247	4480
50	2024	1640	1280	2911	2347	1863	3964	3183	2430	5184	4149	3075	6567	5240	3800	8116	6458	4500	9837	7813	5475
100	2569	2131	1670	3732	3076	2450	5125	4202	3200	6749	5509	4050	8597	6986	5000	10681	8648	5920	13004	10499	7200

TABLE 4

Capacity of TYPE B DOUBLE-WALL VENTS with SINGLE-WALL CONNECTORS

Serving two or more Category I Appliances

Appliance Input Rating in Thousands of BTU per hour

Vent Connector Diameter

Vent Connector		3"			4"			5"			6"			7"			8"			10"		
Height Rise (ft)		FAN		NAT Max	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max	FAN		NAT Max
		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max		Min	Max	
6	1	NR	NR	26	NR	NR	46	NR	NR	71	NR	NR	102	207	223	140	262	293	183	447	463	286
	2	NR	NR	31	NR	NR	55	NR	NR	85	168	182	123	215	251	167	271	331	219	458	524	344
	3	NR	NR	34	NR	NR	62	121	131	95	175	198	138	222	273	188	279	361	247	468	574	385
8	1	NR	NR	27	NR	NR	48	NR	NR	75	NR	NR	106	226	240	145	285	316	191	481	502	299
	2	NR	NR	32	NR	NR	57	125	126	89	184	193	127	234	266	173	293	353	228	492	560	355
	3	NR	NR	35	NR	NR	64	130	138	100	191	208	144	241	287	197	302	381	256	501	609	400
10	1	NR	NR	28	NR	NR	50	119	121	77	182	186	110	240	253	150	302	335	196	506	534	308
	2	NR	NR	33	84	85	59	124	134	91	189	203	132	248	278	183	311	369	235	517	586	368
	3	NR	NR	36	89	91	67	129	144	102	197	217	148	257	299	203	320	398	265	528	637	413
15	1	NR	NR	29	79	87	52	116	138	81	177	214	116	238	291	158	312	380	208	556	596	324
	2	NR	NR	34	83	94	62	121	150	97	185	230	138	246	314	189	321	411	248	568	646	387
	3	NR	NR	39	87	100	70	127	160	109	193	243	157	255	333	215	331	438	281	579	690	437
20	1	49	56	30	78	97	54	115	152	84	175	238	120	233	325	165	306	425	217	546	664	336
	2	52	59	36	82	103	64	120	163	101	182	252	144	243	346	197	317	453	259	558	709	403
	3	55	62	40	87	107	72	125	172	113	190	264	164	252	363	223	326	476	294	570	750	457
30	1	47	60	31	77	110	57	112	175	89	169	278	129	226	380	175	296	497	230	528	779	358
	2	51	62	37	81	115	67	117	185	106	177	290	152	236	397	208	307	521	274	541	819	425
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235	316	542	309	555	855	482
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188	284	604	245	507	951	384
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223	294	623	293	520	983	458
	3	52	72	45	83	136	82	119	221	123	178	353	186	235	486	252	304	640	331	535	1013	518
100	1	45	79	34	71	150	61	104	249	98	153	424	140	205	585	192	269	774	249	476	1236	393
	2	48	80	41	75	153	73	110	255	115	160	428	167	212	593	228	279	788	299	490	1259	469
	3	51	81	46	79	157	85	114	260	129	168	433	190	222	603	256	289	801	339	506	1280	527

Serving two or more Category I Appliances

Combined Appliance Input Rating in Thousands of BTU per hour

Common Vent Diameter

Vent	4"			5"			6"			7"			8"			10"		
Height FT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT	FAN FAN	FAN NAT	NAT NAT
6	NR	78	64	NR	113	99	200	158	144	304	244	196	398	310	257	665	515	407
8	NR	87	71	NR	126	111	218	173	159	331	269	218	436	342	285	730	569	460
10	NR	94	76	163	137	120	237	189	174	357	292	236	467	369	309	787	617	487
15	121	108	88	189	159	140	275	221	200	416	343	274	544	434	357	905	718	553
20	131	118	98	208	177	156	305	247	223	463	383	302	606	487	395	1013	808	626
30	145	132	113	236	202	180	350	286	257	533	446	349	703	570	459	1183	952	723
50	159	145	128	268	233	208	406	337	296	622	529	410	833	686	535	1418	1157	838
100	166	153	NR	297	263	NR	469	398	NR	726	633	464	999	846	606	1741	1459	948

Connectors for Combined Vent Systems

CONNECTOR LENGTH AND CAPACITY

The BTU capacities listed in the sizing tables for common vent connectors are based on a length in feet of 1-1/2 times the connector diameter. For example, the table capacities for a 4-inch connector are based on a maximum 6-foot long connector ($4\text{-inch} \times 1\text{-}1/2 = 6\text{-feet}$). This is true for both single-wall and Type-B double-wall connectors. See table below:

SIZE	3"	4"	5"	6"	7"	8"	10"	12"	24"
LENGTH	4.5'	6'	7.5'	9'	10.5'	12'	15'	18'	36'

Since a longer vent connector will contribute to a greater flow resistance, the maximum vent capacity must be reduced for longer connectors. Also, since a longer connector will permit more heat loss, the minimum capacity must be increased to ensure an adequate amount of heat to avoid condensation.

The maximum capacity of the vent connector must be reduced 10% for each additional multiple of the length listed above. For example, the maximum length listed above for a 4-inch connector is 6 feet. With a connector length greater than 6 feet, but not exceeding 12 feet, the maximum capacity must be reduced by 10% ($0.90 \times \text{MAX capacity}$).

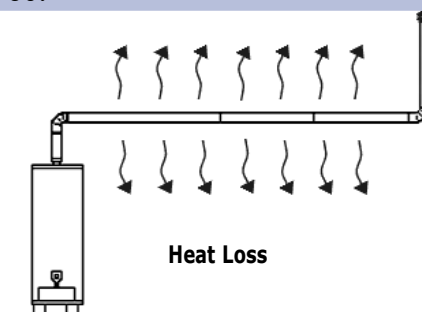
The minimum capacity (FAN Min) of the system should be determined by referring to the corresponding single appliance table (Tables I and II). In this case, for each appliance the entire vent connector and common vent from the appliance to the vent termination would be treated as a single appliance vent, as if the other appliances were not present.

Upon checking Tables I or II, if the appliance fails to meet the minimum capacity, this means that the draft may be insufficient and condensation may occur when the appliance is operated by itself. To solve this problem, the installer may wish to relocate the appliances, require

simultaneous operation of the appliances, or install a separate vent for each appliance.

For draft hood-equipped appliances, a good rule to follow is that the total horizontal distance of a vent plus the horizontal portion of the vent connector should not be greater than 75% of the vertical height of the vent.

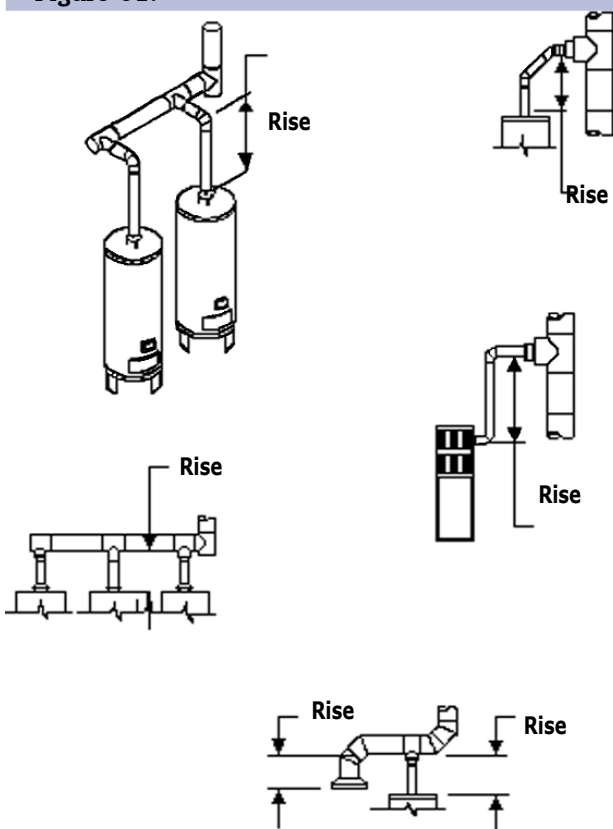
Figure 60.



CONNECTOR RISE

For a common vent system, connector rise is the vertical distance from the appliance outlet to the level at which the connector joins the common vent. See Figure 61 for several examples of how to measure connector rise in multiple appliance installations.

Figure 61.

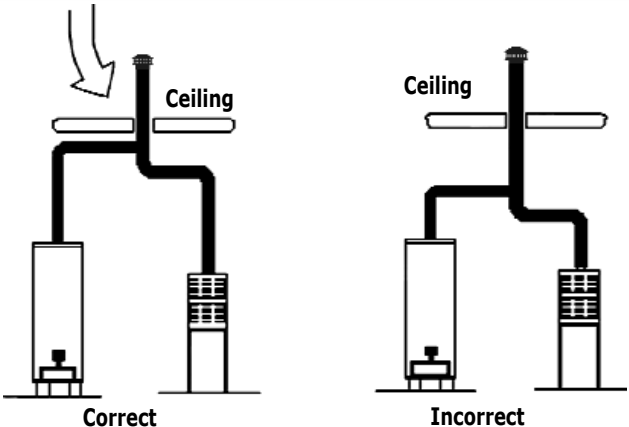


A small increase in connector rise can result in a large reduction in the height of the common vent. This is an important fact that the installer should take advantage of. For example, assume we are common venting a 100,000 BTU NAT appliance with a 5-inch draft hood outlet. Referring to Table III, we find that a 1-foot connector rise requires a 50-foot vent height, a 2-foot rise requires only a 20-foot vent height, and a 3-foot rise requires only an 8-foot vent height. This represents a major cost savings for only a small increase in connector rise.

USE AVAILABLE HEADROOM FOR BEST PERFORMANCE

In a common vent system, the rise in the connector has a major impact on vent performance. As noted, a small increase in connector rise can result in major savings by permitting the use of a much shorter common vent. As shown in Figure 62, the interconnection tee should be installed as high as possible. Take advantage of the Type B gas vent 1-inch clearance to combustibles.

Figure 62.



CONNECTOR SIZE COMBINATIONS

The capacities listed in the sizing tables apply to combining any two draft hood or flue outlet sizes which fall into the ranges listed below:

Small appliance size	3"	4"	5"	6"	7"	8"	10"
Large appliance MAX	7"	10"	12"	14"	16"	20"	24"

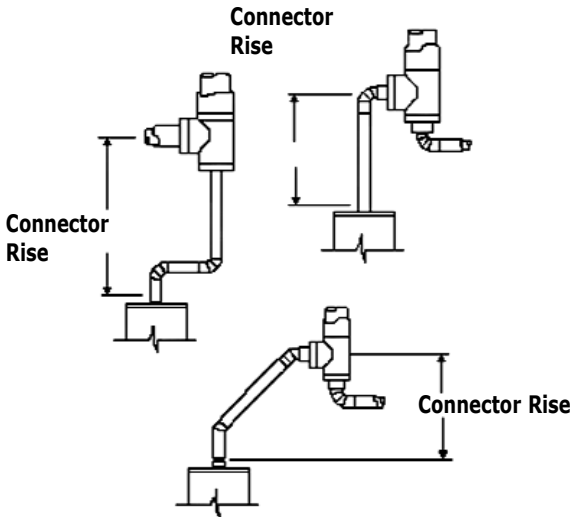
A wider range may be possible, providing you increase the connector rise on the smaller appliance. Another option is

to increase the size of the connector on the smaller appliance, providing its input is greater than the listed minimum capacity at the larger size connector.

OPTIONS FOR CONNECTORS CONFIGURATION

Providing the sizing table requirements are met for connector rise and length, the configuration of the vent connector is not important. As illustrated in Figure 63, the vent connector may run vertically and then laterally, or laterally and then vertical. The vent connector may also be sloped at various angles up to the common vent connection.

Figure 63.



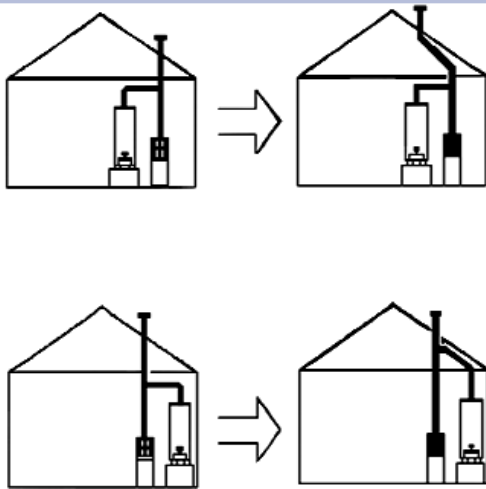
OPTIONS FOR INCREASING VENT HEIGHT AND CONNECTOR RISE

If a common vent cannot be used because of limitations in connector rise or total vent height, alternatives such as those illustrated in Figure 64 may be used to secure a greater connector rise or greater total vent height.

WHEN IN DOUBT USE ONE SIZE LARGER CONNECTOR

It is not possible to anticipate all contingencies in designing a vent system. If there is concern that the vent may not function properly due to a short connector rise, excessive number of elbows, long lateral runs, etc., the next larger size vent connector should be selected. Be sure to increase the connector size all the way down to the appliance outlet, even if the appliance outlet size is smaller than the vent. By increasing the vent connector size, the risk of draft hood spillage or positive pressure problems will be avoided.

Figure 64.



A vent connector which is too large can result in condensation problems, so be sure to check the minimum capacity on fan-assisted appliances.

Common Vents

DEFINITION: A common vent is defined as a vent which serves two or more appliances that are installed on the same floor level. While a common vent is normally considered to be in a vertical orientation, a horizontal manifold would also be considered to be a common vent since it is carrying the gases from two appliances.

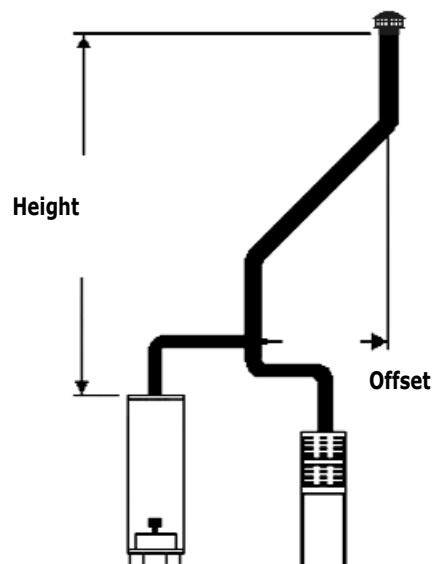
COMMON VENT OFFSET

The capacities listed in the sizing tables for common vents assume that the common vent is a straight vertical installation with no elbows or offsets. If an installation requires that the common vent be offset, this will result in an increase in draft resistance. (See Figure 65.)

Common vent offsets should be installed with as much upward rise as possible. If an offset is needed in the common vent, it must comply with the following rules:

- A. The maximum capacities listed in the common vent tables must be reduced by 20%, the equivalent of two 90° elbows ($0.80 \times \text{MAX common vent capacity}$); and
- B. The horizontal length of the offset should not exceed 1-1/2-feet for each inch of common vent diameter. For example, a 6-inch common vent should not be offset more than 9 feet.

Figure 65.



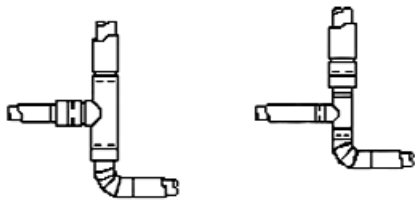
C. For each additional 90° turn in excess of two, the maximum capacity of that portion of the venting system shall be reduced by 10% (0.90 x MAX common vent capacity). Two or more turns, the combined angles of which equal 90°, shall be considered equivalent to one 90° turn.

Offsets should be measured only in the horizontal direction as indicated in Figure 65. A 45° slope will have an offset dimension approximately equal to 0.70 x offset length.

SIZE OF INTERCONNECTION FITTINGS

Tees or wye's used to join vent connectors with the common vent must be the same size as the common vent, as shown in Figure 66. A tee or wye which is too small will result in a major obstruction to the flow of the flue gas when both appliances are operating. Reduction tees and wye's are available which have smaller branches and bases. These reduction fittings eliminate the need for vent increasers between the connectors and the fitting. These can be particularly helpful in tight installations where space is at a premium.

Figure 66.



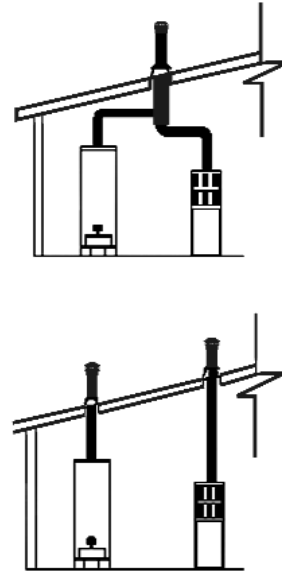
COMMON VENT SIZE

It is often assumed that a 3-inch water heater, combined with a 4-inch furnace, will require a 5-inch common vent, however, in many cases the sizing tables will properly call for a 4-inch common vent. This is particularly true when the installation has a tall connector rise or a tall common vent height. Be sure to check the tables and take advantage of this low cost option!

The two rules for common vent size which must be followed are:

1. The common vent must not be smaller than the largest connector, and

Figure 67.



2. If vent connectors are combined prior to entering the common vent, the maximum common vent capacity listed in the common vent tables must be reduced by 10% (0.90 x maximum common vent capacity).

COMMON VENT ALTERNATIVES

It is important in a combined vent system that the cost of individual versus combined vents be considered. This is particularly true for short installations with low attic space and/or flat roofs. The potential savings in pipe diameters, elbows, tees, and other fittings may result in a lower cost installation, as shown in Figure 67.

Two individual vents provide for better vent performance since they are sized for each specific appliance. In contrast, the common vent is somewhat oversized when only one appliance is operating.

Manifold Venting

DEFINITION: A manifold is a vent or connector which is a horizontal extension of the lower end of a common vent.

MANIFOLD SIZING

Since a manifold carries flue gases from two or more appliances, this portion of the venting system must be sized using the common vent tables. Since the common vent table list the capacities of a vertical common vent, with no tees, these capacity values must be reduced for the horizontal manifold.

To determine the proper manifold size and capacity, the BTU capacity values listed in the common vent tables must be reduced 10% ($0.90 \times \text{capacity}$). The 10% reduction applies regardless of the length of the horizontal manifold. For entering the common vent tables, be sure to use the vent height from the tallest appliance connected to the manifold.

The above procedure will determine the maximum BTU capacity for the manifold. For fan-assisted appliances, the minimum BTU capacity is also important. If one appliance is allowed to operate individually, will there be sufficient heat input to avoid condensation in the venting system?

To determine the minimum BTU capacity, refer to the single appliance table and treat the entire venting system as a single appliance vent of the same size as the common vent. Each appliance is checked individually, as if the other appliances do not exist. Any appliance with a BTU capacity less than the FAN Min value may have a tendency to form excessive amounts of condensation and/or insufficient draft if operated individually.

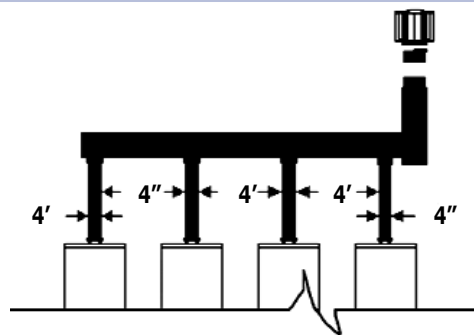
When installing several fan-assisted appliances on a manifold system, the potential for excessive condensation may be reduced by including a draft hood-equipped appliance in the system. The dilution air entering the draft hood appliance will help reduce the potential for condensation by lowering the dew point temperature and drying out the manifold during the off cycle.

MANIFOLD LENGTH

The maximum length of a manifold in feet must not exceed $1\frac{1}{2}$ times the diameter of the manifold in inches. For example, a 6-inch size manifold must be no greater than 9 feet in length.

When several appliances are connected to a horizontal manifold, the appliances should be installed as close together as practical. A good rule is the distance between appliance connectors in feet should not exceed the connector diameter in inches. For example, if the appliance connectors are 4 inches in diameter, the connectors should enter the manifold at a distance no greater than 4 feet apart. (See Figure 68.)

Figure 68.



Follow the rules for proper manifold sizing, particularly with fan-assisted gas appliances which have a tendency to form condensation. For maximum heat input to the manifold system, it is preferable that all appliances cycle on simultaneously, however since load demands frequently require sequential operation, the appliance that is installed closest to the vertical common vent should be the first appliance to cycle on.

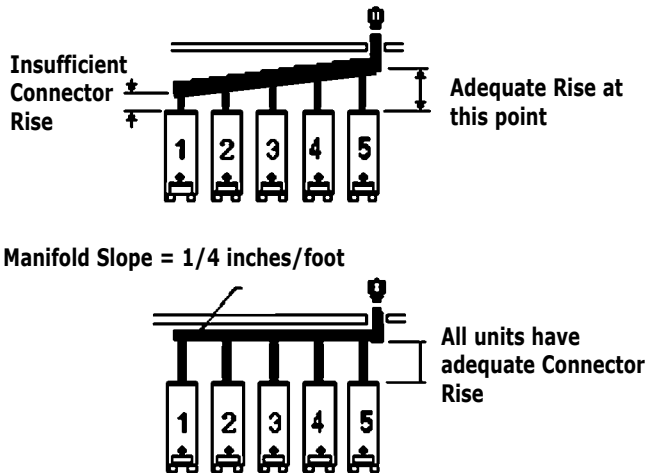
HORIZONTAL VS. SLOPED MANIFOLDS

Excessively sloped manifolds do not improve venting. Since proper connector rise is necessary for all appliances, a sloped manifold may result in draft hood spillage or a pressurized vent for the appliance most distant from the vertical vent. As illustrated in Figure 69, the sloped manifold results in insufficient connector rise and may result in spillage on appliance 1, and possibly 2 and 3.

CAUTION: When local codes require a $\frac{1}{4}$ -inch per foot

slope on manifolds, be sure that all connectors have at least the minimum rise in accordance with the vent connector tables. Given the choice between a horizontal manifold or inadequate connector rise, it is preferable to select a horizontal manifold.

Figure 69.



MANIFOLD CONNECTORS

Vent connectors from multiple appliances, installed on the same floor level, may enter the manifold from below or from the side of the manifold. In either case, the connector rise should be measured as the vertical distance from the appliance outlet to the lowest level at which the connector enters the manifold. All connectors to the manifold must have the required minimum rise.

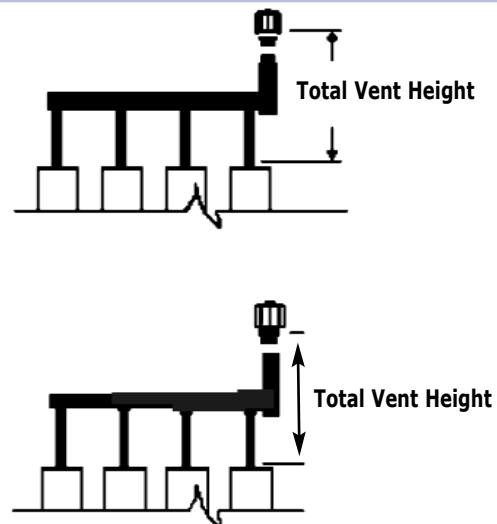
TAPERED OR CONSTANT SIZE MANIFOLDS

There are two types of manifolds, tapered and constant. Tapered manifolds are designed such that each section of the manifold is sized for the volume of gas flowing through that particular section. Constant manifolds are designed with the entire manifold and common vent being one constant size. Both types of manifolds are acceptable with no significant difference in operating performance. A choice can be made on the basis of cost and convenience.

TAPERED MANIFOLD: To properly size a tapered manifold, size each section individually starting with the smallest diameter section furthest from the common vent. Enter the common vent tables using only the BTU input flowing into the smallest manifold section. As the connectors from additional appliances enter the manifold, the manifold size must be stepped up to handle the total BTU input flowing into each section of the manifold. Remember, the maximum capacity of each section of the manifold must be reduced by 10% (0.90 x capacity) from the values listed in the common vent tables.

CONSTANT SIZE MANIFOLD: To properly design a constant size manifold, add up the BTU inputs for all appliances connected to the manifold and use this total BTU input value to enter the common vent tables. The maximum capacity values listed in the common vent tables

Figure 70.



must be reduced by 10% (0.90 x capacity) since this is a horizontal manifold, not a vertical common vent.

NUMBER OF MANIFOLD APPLIANCES

When connecting multiple appliances into a manifold or common vent, there are sizing restrictions that must be followed. The flow area of the manifold/common vent cannot be greater than seven times the flow area of the flue collar or appliance outlet of the smallest appliance. Remember to get the most rise from the connector as possible, as adequate connector rise is essential to preventing draft hood spillage or vent pressurization.

For example, an appliance with a 3-inch connector has an area of 7 sq. in. 7 times that area is equal to 49 sq. inch ($7 \times 7 = 49$). Therefore, the total cross sectional area of all other appliance connectors combined exceed 49 square inches.

<u>SIZE</u> <u>---AREA</u>	<u>SIZE</u> <u>-----AREA</u>
3 inch - 7 sq. inches	12 inch - 113 sq. inches
4 inch - 13 sq. inches	14 inch - 154 sq. inches
5 inch - 20 sq. inches	16 inch - 201 sq. inches
6 inch - 28 sq. inches	18 inch - 254 sq. inches
7 inch - 38 sq. inches	20 inch - 314 sq. inches
8 inch - 50 sq. inches	22 inch - 380 sq. inches
10 inch - 78 sq. inches	24 inch - 452 sq. inches

SINGLE APPLIANCES WITH TWO OR MORE DRAFT HOODS OR FLUE OUTLETS

Instructions for proper manifold installation should be furnished by the manufacturer of appliances with two or more outlets. In their absence, the area of the manifold and its outlet connector should equal the sum of the outlet areas. If it is possible to shut off one or more of the side-by-side sections of such an appliance, all connectors into the manifold should conform to the connector rise provisions in the tables. The appliance will be operating as a combined vent, producing hot gases from only one section. If the sections cannot be shut off individually, the remainder of the vent system may be designed as an individual vent; otherwise, use the appropriate common vent table.

Multi-story Venting

A multi-story venting system is a means of common venting gas appliances that are located on two or more floors in a multi-story building. Each floor level may have two or more appliances connected to the vertical common vent with a vent manifold or a single appliance connected to the vertical common vent with a vent connector. The appliances may serve a single occupancy or an entire floor level.

INDIRECT APPLIANCES

An indirect appliance is one which does not draw combustion air from an occupied living space. Indirect appliances are typically installed in closets or furnace rooms which are separated and remote from all occupied living spaces. Outside air is provided through air vents located on an outside wall or through a chase or an air well which is non-habitable. Examples of indirect appliances are water heaters and Category I furnaces located in a closet.

DIRECT APPLIANCES

A direct appliance is one which does draw its combustion air from an occupied living space or any area which is free to communicate with an occupied space. Room heaters, wall furnaces, floor furnaces, and vented decorative fireplaces are all examples of direct appliances which draw combustion air from occupied living spaces. Note: Fireplaces vented with "direct vent" double-wall venting system, designed to not only exhaust the flue gas but also draw in outside air for combustion, fall under the category of "Indirect Appliances."

Direct appliances should not be installed with a multi-story, common vent type system.

In the event of a blockage at the vent cap or some other point higher up in the system, the flue gas could back up and spill out into an occupied living space on an upper floor level. Since safety devices on the operating appliance

could only detect spillage or oxygen depletion in the occupied space near the appliance, spillage on an upper floor would go undetected. This same situation could occur in the event of a flow reversal due to high wind or a fan operating in a tightly sealed building. For these reasons, direct appliances should always be installed with an individual vent and not interconnected on a multi-story vent system.

IMPORTANT SAFETY FACTORS

When designing a multi-story venting system, it is very important to pay close attention to these three safety factors:

1. **Separation:** The appliance room must be separated from any occupied living space, preferably with sole access from an outdoor balcony or a well-ventilated service area. A normally closed, solid door between the appliance room and occupied living space is less desirable than access through an outside door.
2. **Air Supply:** The air supply to the appliance room must always come from outdoors, feeding into the appliance room through louvers, ducts, air wells, or chases. No ventilation or combustion air should be taken from inhabited or occupied spaces within the building.
3. **Vent Design:** Proper sizing of both the vent connectors and the common vent is of critical importance with a multi-story venting system. Be sure to strictly adhere to the design and sizing recommendations contained in the sections to follow. The recommendations have been verified by laboratory testing for both draft-hood and fan-assisted combustion appliances and have proven sound over many years of successful operation.

SEPARATION FROM OCCUPIED SPACES

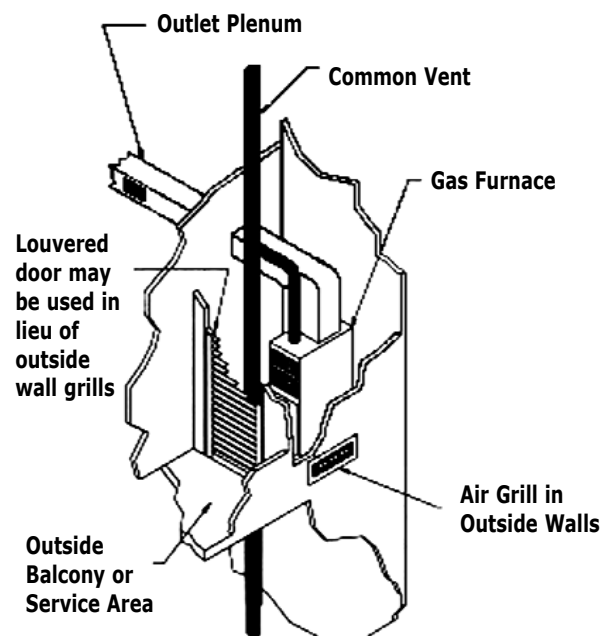
The separation of gas equipment from occupied spaces resolves the questions of safety arising from intercommunication of vents between various levels of a building. Separation insures that no flue products or vent gases can enter the building from the equipment room in case the common vent becomes obstructed at any level or

the outlet is blocked. When such stoppage occurs, all vent gases from appliances operating below the obstruction will exit through the louvers, rather than through the vent outlet. Large quantities of flue products will be dumped into the space containing those appliances immediately below the obstruction while, at the same time, appliances at lower levels will appear to be operating normally.

Since fan-assisted gas appliances do not have a draft hood, spillage will not occur, however, a vent blockage will cause the flue products to back up into the combustion chamber, which may cause back pressure problems. The appliance could shut down due to the pressure sensor, for example.

One practical plan, used to separate or isolate the gas equipment, is illustrated in Figure 71. Access to the gas equipment is through a door opening onto an outdoor balcony.

Figure 71.



AIR SUPPLY

For indirect appliances delivering hot water or warm air to individual occupancies, a properly designed air supply serves several vital functions. Besides providing the gas units with air for combustion, ventilation, and draft hood dilution, an adequate air supply will maintain safety despite any venting obstruction or difficulties. Thus, the air supply to the equipment room serves these five functions:

1. Combustion air for the gas flame.
2. Draft hood dilution air for proper venting.
3. Ventilation air to avoid heat accumulation.
4. Discharge to the atmosphere of vent gases escaping from appliances in the room.
5. Discharge of vent gases accumulating in any appliance room, caused by venting obstructions in the common vent.

METHODS FOR PROVIDING AIR SUPPLY

Air for indirect gas appliances located in separate rooms in a multi-level building should be taken from outside through building walls, from within air wells, or from ventilated chases. Occupancy of levels above and below every floor restricts the choice to horizontal supply through ducts or louvers, such as that shown in Figure 72. The other methods illustrated in Figures 77 and 78 are not applicable, as they presuppose ventilated attics or crawl space or they nullify the separation principle by using air from occupied spaces.

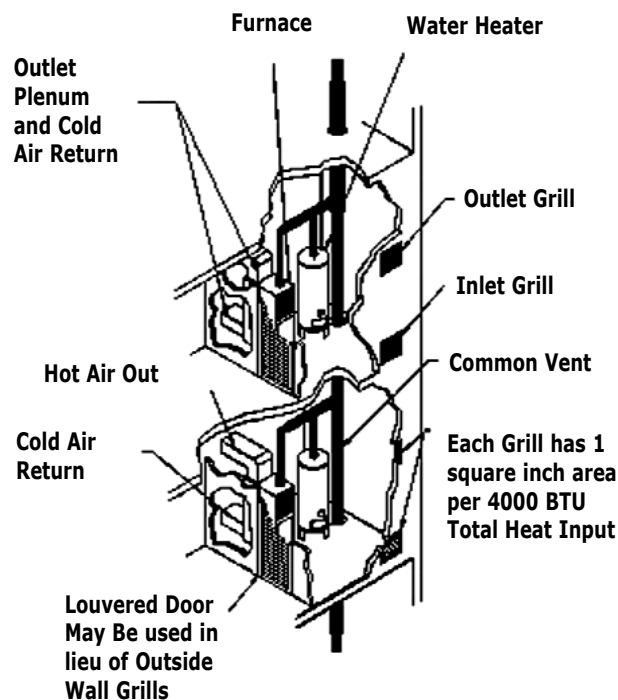
To illustrate the ready applicability of the outside wall method, Figure 72 shows a small portion of a typical high-rise venting system. A change to horizontal ducts would permit the appliance room to be more centrally located.

Air supply to gas appliance rooms in multi-story buildings, using the outside wall as shown in Figure 72, simply involves two wall louvers, one located within 12 inches of the floor level and one located within 12 inches of the ceiling.

The required area for openings or ducts depends on the type of appliance(s) and the BTU input of the appliance(s). The area required for ducts is twice the area required for a grill or louver type opening.

<u>Ducts</u>	<u>Wall Opening</u>
Draft hood only 1 sq in/ 2,000 BTU	1 sq in/4,000 BTU
Draft hood + Fan-Assisted 1 sq in/ 2,000 BTU	1 sq in/4,000 BTU
Fan-Assisted only 1 sq in/ 4,000 BTU	1 sq in/8,000 BTU

Figure 72.



Multi-story combined vents are often installed within a vertical chase or central core, running from the lowest building level up through the roof. Use of this chase for ventilation air may further facilitate the location of appliance rooms by eliminating dependence on an outside wall location for air supply. To serve as a ventilation air supply, the chase should communicate with the outdoors at both top and bottom, permitting normal thermal effects to create flow and assure a supply of fresh air at all levels.

MULTI-STORY VENTING OF CATEGORY III OR IV APPLIANCES

Category III and IV appliances operate with a forced-draft, positive pressure venting system. Several problems exist when attempting to vent forced-draft appliances in a multi-story application.

For vertical forced-draft venting the problems include:

1. Forced-draft systems depend on a fan due to a lack of heat (buoyancy) in the flue gas. In a multi-story system, the fan must be operated continuously to ensure adequate draft for all other appliances connected to the venting system (incurring electric

power cost and increasing building heat loss).

2. Failure of a forced draft fan will require the shut down of all appliances using the multi-story venting system. Forced draft systems require safety controls to prevent operation of appliances in the event of a fan failure.

3. Should a forced-draft fan fail, this system can provide a route for fumes, odors, etc., from one unit to enter dwelling areas of other units.

For horizontal through-the-wall venting of forced-draft appliances the problems include:

1. The large number of stack terminations on the side of a building may produce an unacceptable appearance, either on their own or from plumes produced by the vent gases.
2. The proximity of the combustion air supply duct to the vent discharge may induce combustion products to re-circulate into the appliance.
3. Combustion products may enter other openings (i.e., windows) in the proximity of the vent discharge.
4. Condensate disposal problems in a multi-story building.

APPLYING COMBINED VENT TABLES TO MULTI-STORY VENT SYSTEMS

The following general design method for multi-story vents uses the Common Vent Tables and is intended for use only with indirect gas appliances. As with simple common vent designs, the common vent and connector rise must act jointly to vent all attached appliances without causing draft hood spillage or positive pressure in the connector from a fan-assisted appliance.

DESIGN PRINCIPLES

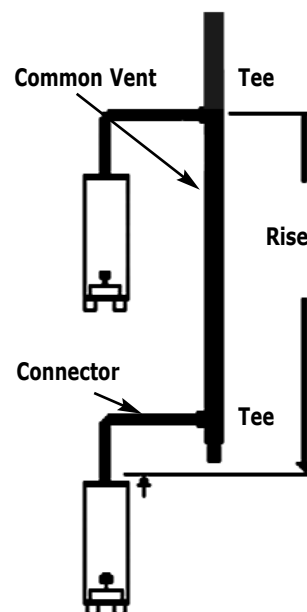
Providing the multi-story vent is properly designed, there is no limit to the height of the system nor to the number of floors which may be served by the system. The vent system will function properly when one appliance, or any combination of appliances, is operating.

A typical multi-story vent configuration is illustrated in Figures 73 and 74. Be sure to study both illustrations carefully.

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

1. The overall system should be divided into smaller, simple combined vent systems, each with the minimum total height equal to the sum of connector rise plus distance between tees. (See Figure 73.)
2. Each vent connector from the appliance to the vertical common vent should be designed from the vent connector table using the same procedure as was used for simple one level common 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 of all appliances discharging into it.
4. The vent connector from the first floor or 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

Figure 73.



appliance having a total vent height measured to the outlet of the common vent.

5. The appliance on the top floor must have a total vent height sufficient to accommodate the total combined input from below, as well as an adequate height required by the appliance's vent connector. As a result, this may require a large common vent size or a greater common vent height above the roof line. To avoid this expense plus provide an increase in vent height for the next lower appliance, it may be preferable to vent the top appliance with its own individual vent.

PRECAUTIONS IN DESIGNING MULTI-STORY VENT SYSTEMS

1. Common vent height must always be computed as the distance from the appliance outlet to the lowest portion of the next tee interconnection above. No credit should be given for any height of common vent above the next interconnection.

2. A multi-story common vertical vent is allowed to have a single offset, provided all of the following requirements are met:

- a. The offset angle does not exceed 45°.
- b. The horizontal length of the offset does not exceed 1-1/2 feet for each inch of common vent diameter of the segment in which the offset is located.
- c. For the segment of the common vertical vent containing the offset, the common vent capacity listed in the common venting tables is reduced by 20% (0.80 x MAX common vent capacity).
- d. A multi-story common vent shall not be reduced in size above the offset.

3. If the connector rise is inadequate, increase the connector size, always making use of maximum available connector rise.

4. The vertical common vent will increase in size at upper floor levels so as to accommodate the total cumulative rated input of all appliances attached

below. The vertical body of each interconnection tee must be the same size as the common vent above it. Increases should be used between the common vent and the larger tee size above, and between the tees and the appliance connectors.

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. Be sure to check local building code requirements for restrictions on common vent location, use of fire resistant materials, etc.

6. Check with local codes for possible restrictions about locations of appliances or vents for multi-story installations.

EXAMPLE OF MULTI-STORY VENT DESIGN

Figure 74 shows a typical example of a multi-story vent system consisting of four 90,000 BTU appliances, each with a 5-inch draft hood outlet. The minimum total vent height is 10 feet for each of the three lower floors and 6 feet for the top floor.

The following table shows the calculations for venting all four floors into the common vent.

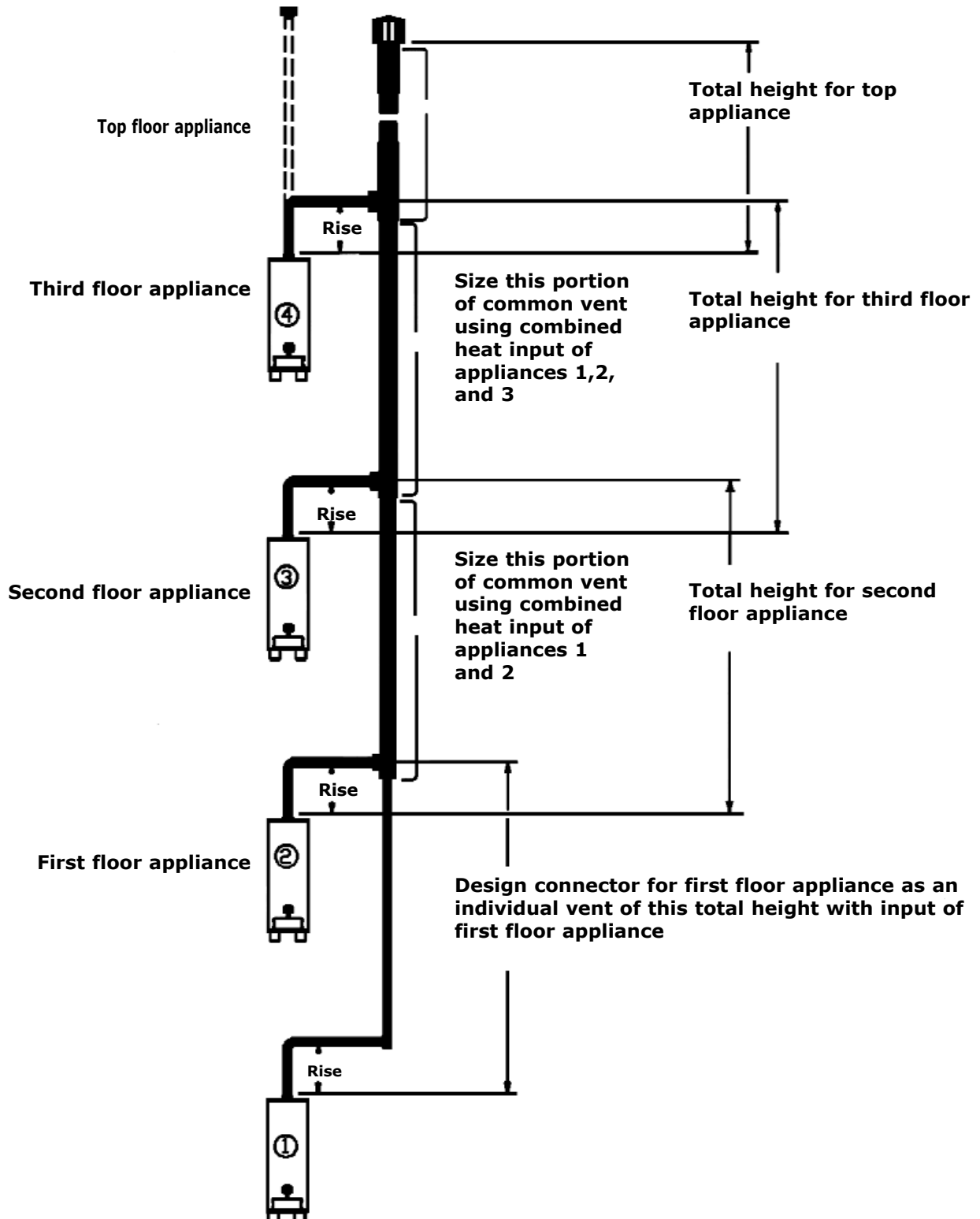
Total Appliance	Connector Input	Available Connector Rise	Min Total Size Height	Connector Size	Common Vent Size
1	90,000	10'	10'	5"	self-venting connector
2	180,000	1'	10'	6"	7"
3	270,000	1'	10'	6"	7"
4	360,000	1'	6'	5"	10"

If the heater on the top floor is vented separately, the following table shows the result of increasing the Minimum Total Vent Height of the third floor appliance to 16 feet and decreasing total input to the common vent to 270,000 BTU per hour.

Figure 74.

Use individual vent for top floor appliance if connector rise requirement or total height cannot be met

Size this portion of common vent using total height for top floor appliance and combined heat input of appliances 1,2,3, and 4



Providing Air Supply

Total Appliance	Connector Input	Available Connector Rise	Min Total Size Height	Connector Size	Common Vent Size
1	90,000	10'	10'	5"	self venting connector
2	180,000	1'	10'	6"	7"
3	270,000	1'	16'	6"	7"
4	90,000	8'	6'	5"	self-venting connector

The second table indicates the economics of venting the top floor separately, which eliminates the larger sizes of vent pipe and the use of additional, costly fittings.

RATIO OF CONNECTOR SIZE TO COMMON VENT SIZE

As previously explained in Manifold venting, the area of the common vent cannot be more than 7 times the area of the vent connector entering it. As the common vent is increased in size at upper floors, the flow area of the common vent might exceed the seven times the flow area of the flue collar of appliance outlet at those floors. This requirement does not apply to systems employing self-venting connectors, where the connector rise was originally over 5 feet.

ECONOMY OF PARALLEL SYSTEMS

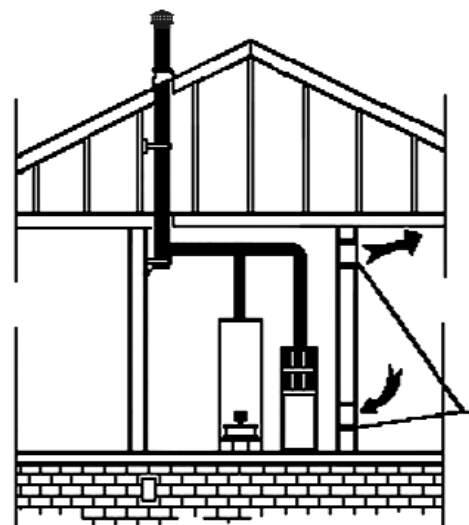
It may prove more economical to group appliances to upper and lower common vent systems so that smaller vent sizes can be used. Even though many appliances may be connected to a single multi-story common vent, the increase in size may prove uneconomic. Space requirements and the number of fittings increase as more appliances are common vented. An alternate procedure is to use parallel common vents with staggered connections at alternate floors, thereby greatly increasing the minimum total vent height available to each connected appliance.

AIR SUPPLY CONFIGURATION

It is important that all gas appliances and venting systems have an adequate air supply for combustion and venting. Figures 75, 76, 77, and 78 show typical air supply configurations. In designing a venting system, these suggested configurations should be used. The configurations are based on information contained in the National Fuel Gas Code, NFPA 54, ANSI Z223.1.

When installing the two louvers, install one louver at or below the combustion air opening of the appliance. Install the other louver near the ceiling above the relief opening of any draft hood. Even for short appliances, the distance between the louvers should never be less than 3-1/2 feet. If connected with duct, the cross sectional area of the duct shall not be less than the free area of the attached louver.

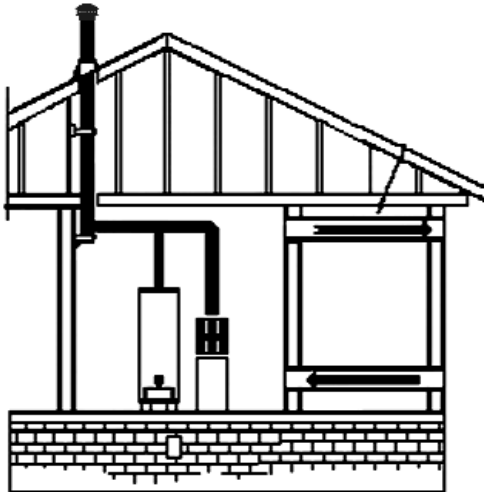
Figure 75.



ALL AIR FROM INSIDE BUILDING

Note: Each opening shall have a free area of not less than one square inch per 1,000 BTU per hour of the total input rating of all appliances in the enclosure.

Figure 76.

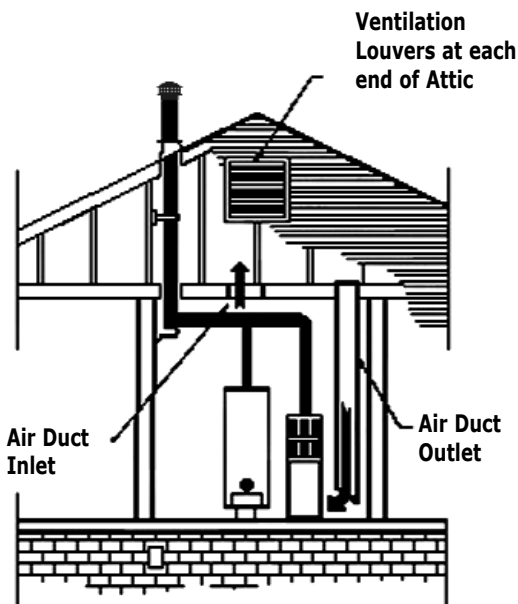


ALL AIR FROM OUTDOORS

Note: Each air duct opening shall have a free area of not less than one square inch per 2,000 BTU per hour of the total input rating of all appliances in the enclosure.

* In Figure 76, if the appliance is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than one square inch per 4,000 BTU per hour of the total input rating of all appliances in the enclosures.

Figure 77.

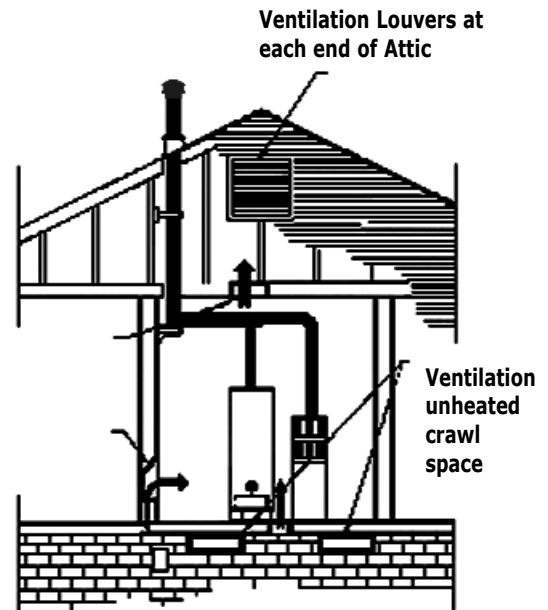


ALL AIR FROM VENTILATED ATTIC

Note: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 BTU per hour of the total input rating of all appliances in the enclosure.

$$\text{Free Area of each Duct or Grill} = \frac{\text{Total Input}}{4000}$$

Figure 78.



AIR FROM CRAWL SPACE, OUT INTO ATTIC

$$\text{Free Area of each Grill} = \frac{\text{Total Input}}{4000}$$

Note: The inlet and outlet air openings shall each have a free area of not less than one square inch per 4,000 BTU per hour of the total input rating of all appliances in the enclosure.

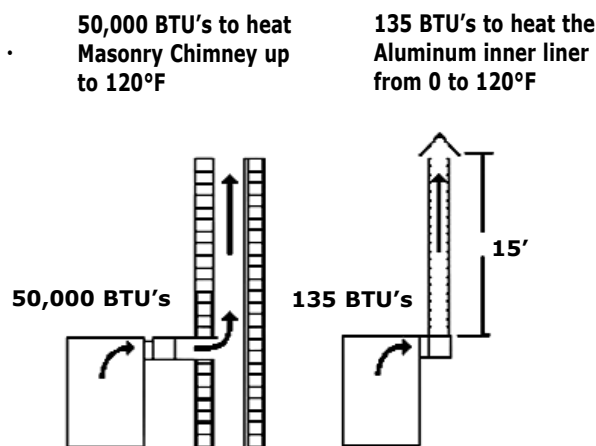
Masonry Chimneys

Cold, oversized masonry chimneys are simply no match for today's modern gas appliances.

As we have discussed, it is of critical importance that a venting system heat up rapidly to ensure a strong draft and minimal condensation. It is important that the system be sized properly and to avoid having the vent exposed to cold outdoor temperatures. On all counts, the masonry chimney violates the basic rules of proper venting.

For example, a 15-foot high Type-B gas vent system requires 135 BTU's for the inner liner to reach 120° F. In contrast, a 15-foot high exterior masonry chimney, exposed to cold outdoor temperatures, requires more than 50,000 BTU's to heat the heavy mass of brick up to 120° F. Even an interior masonry chimney would require over 25,000 BTU's.

Figure 79

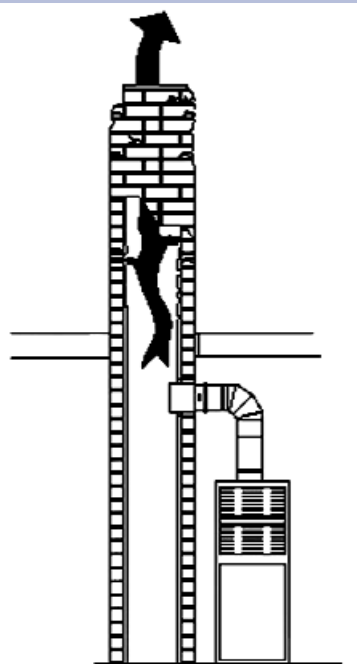


As a result, a masonry chimney (with or without a clay flue tile liner) does not heat up to a high enough temperature to ensure an adequate draft and to avoid massive amounts of condensation. With condensation continuously running down the cold surface of the masonry, large quantities of water soak into the mortar. This results in two serious problems. First, the water eventually soaks through the chimney, damaging interior walls and ceilings. Second, water soaking into the masonry can result in substantial

damage to the chimney due to a “freeze/thaw” phenomenon. As the water in the mortar freezes, it expands. This causes the mortar and bricks to disintegrate, leading to the destruction of the entire chimney.

Perhaps of even greater concern is the danger of having flue products leak out of the masonry chimney and flow into the living space, instead of up and out of the chimney. Cracked flue tiles, hidden deterioration of the masonry, and eventual “freeze/thaw” damage to the mortar can all provide avenues for the flue products to travel directly into the building. This is of particular concern since the flue products are chilled as they pass through the cold masonry flue, leading to a sluggish flow of gas that can back-up inside the chimney, eventually leaking out into the occupied living space. New sizing tables and vent requirements for masonry chimneys have been adopted by the American Gas Association and GAMA (Gas Appliance Manufacturer's Association). These requirements state:

Figure 80.



“Single appliance venting of a fan-assisted furnace into a tile lined, masonry chimney is prohibited.”

The new tables require that a chimney be lined with Type-B gas vent or a single-wall metal lining system. While the tables do permit draft hood-equipped appliances or a combination of a draft hood appliance and a fan-assisted appliance to be vented into a tile-lined masonry chimney, these instructions only apply to internal masonry chimneys,

as opposed to exterior chimneys. The AGA/GAMA sizing tables state:

“The venting tables included in this instruction apply to vents and chimneys internal to the structure below the roof line. Exterior chimneys or vents not enclosed by the structure or a chase below the roof line may experience continuous condensation depending on locality.”

As of the date of this publication, it is our understanding that the AGA/Battelle Laboratories investigation into masonry chimney venting problems has been limited to testing only internal masonry chimneys maintained at a laboratory temperature of approximately 70° F. Unfortunately, funding for the refrigeration systems necessary to evaluate exterior masonry chimneys was not provided. Exterior masonry chimneys exposed to freezing outdoor temperatures would be expected to produce a dramatic increase in condensation related problems.

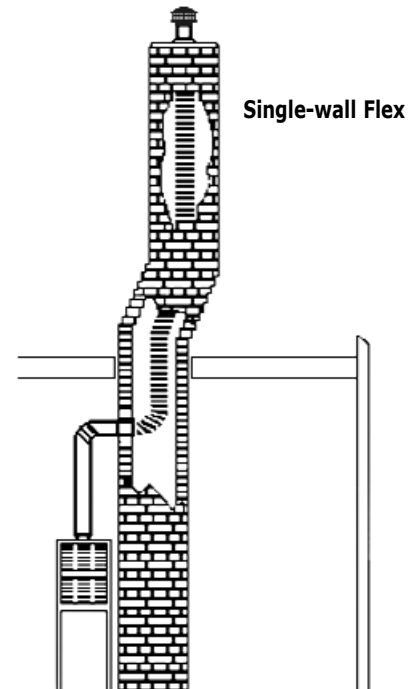
Simpson Dura-Vent, along with many other vent and appliance manufacturers, recommends that no gas appliance, including draft hood-equipped appliances, be vented into a masonry chimney without a listed metal chimney liner system. This recommendation applies to both interior and exterior masonry chimneys, regardless of whether or not the chimney has a clay flue tile liner.

INTERIOR MASONRY CHIMNEYS

For interior masonry chimneys, enclosed within the building on all four sides and, thus, exposed to cold outdoor temperatures only above the roof line, we recommend the use of the Simpson Dura-Vent corrugated aluminum flex system. Long lengths of corrugated aluminum flex provide proper sizing from top to bottom, and the .010 inch thick aluminum flex heats up rapidly to minimize condensation. It is important to cap the top of the chimney to keep cold outdoor air from flowing down inside the air space between the metal liner and the brick.

When using single-wall flex type systems, it is preferable to switch to double-wall Type-B gas vent near the top exposed cold portion of the chimney above the roof line. At this point, the flue gas has lost much of its heat and is susceptible to condensation and poor draft. The use of a combination system of flex with Type-B gas vent near the top of the masonry chimney also provides for double-wall pipe at the exterior vent termination. It also provides a

Figure 81.



means of extending the height of the venting system if the height of the masonry chimney is inadequate. Adapters for converting flex to double-wall Type-B gas vent are offered as an option with the Simpson Dura-Vent DuraFlex Chimney Liner System.

For proper sizing of the corrugated flex chimney liner system, follow the same rules and sizing tables used with Type-B gas vent. The only difference is that, due to the increased flow resistance resulting from the corrugated wall surface, the maximum capacity listed in the sizing tables must be reduced by 20% (0.80 x maximum capacity).

Note: This rule does not apply to the Dura/Connect flexible connector system for use between the appliance and the vent as a vent connector. The flex used in the Dura/Connect system has been intentionally oversized so as to compensate for any increase in flow resistance.

EXTERIOR MASONRY CHIMNEYS

For exterior masonry chimneys, typically exposed on one or more sides to the cold outdoor temperatures, we recommend using a double-wall, Type-B liner system. If flexible lengths are required to accommodate offset type chimneys, it is advisable to restrict the single-wall flexible pipe to a minimum length and to consider wrapping the flex in a fire resistant ceramic blanket type insulation.

Figure 82.

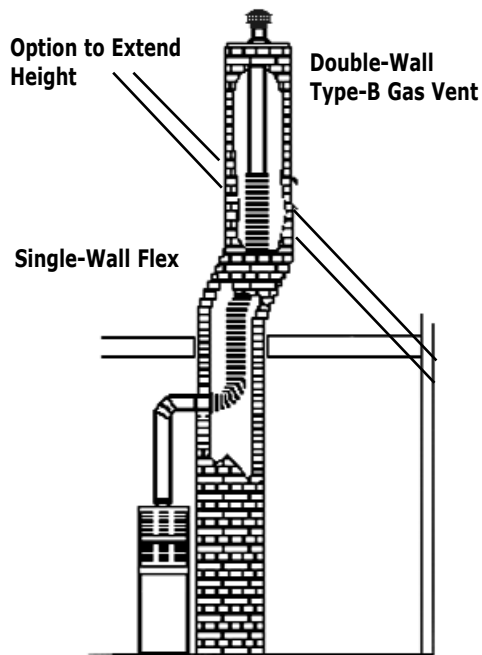
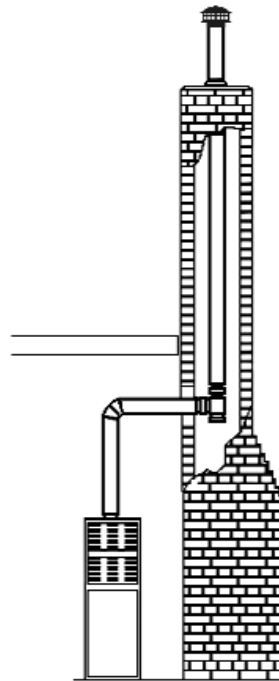


Figure 83.



CHIMNEY LINER INSTALLATION

For proper sizing of the Simpson Dura-Vent DuraFlex chimney liner system, refer to Sizing Tables I, II, III, and IV.

Before installing a chimney liner system, the chimney passageway should be examined to ascertain that it is clear and free of obstructions and should be cleaned if previously used for venting solid or liquid fuel-burning appliances or fireplaces.

If two appliances are to be common vented into the chimney liner their connectors may enter the common vent (liner) through tees at separate levels, or they may be combined immediately prior to entering the chimney liner with a tee or wye type fitting. When two connectors enter the liner at separate levels, the smaller connector should enter at the highest level consistent with available headroom or clearance to combustible material. Two chimney liner tees may be inter-connected for common venting applications.

If a draft hood-equipped appliance is to be vented into a masonry chimney without a chimney liner (not recommended), the chimney's tile liner should be closely examined for any possible deterioration and repaired as necessary. All fireplace openings must be permanently sealed and any clean-out doors must be checked to ensure a tight seal. The vent connector should enter the chimney

at a safe distance above the extreme bottom of the chimney to avoid blockage, and an adequate space should be maintained between the end of the connector and the opposite wall of the chimney flue. The installer must refer to the sizing tables in the National Fuel Gas Code to determine the minimum and maximum chimney dimensions for draft hood-equipped appliances vented into masonry chimneys.

A permanent label should be attached at the point where the connection to the chimney liner is made stating, "This gas vent is for appliances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators."

Vent System Design Methods

For vent and chimneys systems of an extremely complex design, or in very large sizes, the installing contractor is advised to consult with an accredited engineering firm capable of evaluating the system requirements and designing an “engineered vent system.”

The engineering methods for vent and chimney design may be found in the ASHRAE HANDBOOK, Chapter 26, and contain in-depth discussion on a wide range of technical subjects including:

- Water Heater
- The Chimney Design Equation
- Mass Flow and Heat Transfer
- Theoretical Draft
- System Flow Losses and Gas Velocity
- Resistance Coefficients
- Design Graphs & Capacity Calculations
- Vent & Chimney Materials

The installing contractor may also wish to refer to the current edition of the National Fuel Gas Code, the Gas Appliance Manufacturers Association (GAMA) Venting Tables, and the local building codes.

In addition, as a service to our customers, Simpson Dura-Vent provides a free 800 phone line with technical engineers available to assist you in finding answers to your venting questions.

TROUBLE-SHOOTING METHODS

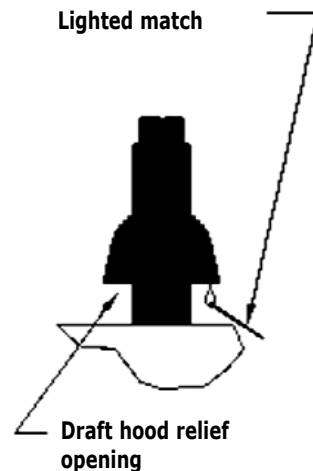
While the sizing methods and vent design procedures set forth in this handbook should normally result in trouble-free operation of your appliance and venting system, it is possible that despite following these guidelines you may

still experience some occasional problems. The operational features of appliances do differ in some respects, and the environment surrounding the venting system may be a significant factor in vent performance. As a result, it may be necessary to deviate from the capacity rules and tables and, perhaps, deviate from the local building codes. Of course, this should only be done after very careful consideration and proper consultation.

DRAFT HOOD SPILLAGE

While it is normal to have a little gas escape from the draft hood opening upon start up, this spillage should occur for no longer than 1 to 2 minutes. The method of testing for draft hood spillage is illustrated in Figure 84. After allowing the vent to warm up for a couple of minutes, hold the match up to the draft hood opening as illustrated. If the appliance and vent are operating properly, the flame should be drawn toward the draft hood. If the match goes out, this may indicate that flue gas is spilling out of the draft hood.

Figure 84.



If the flue gas spillage at the draft hood is related to the vent system, common causes of draft hood spillage include:

1. A partial or total blockage in the vent system.
2. An excessively long single-wall connector run.
3. A very cold environment with exposed single-wall connectors.

4. The vent height is too short or has too many elbows.
5. Vent or vent connectors undersized.
6. Inadequate connector rise.
7. Improper vent cap - too restrictive.
8. Negative atmospheric pressure - fans, etc., within the building.
9. Large temperature differential indoors/outdoors.
10. Wind effects.
11. Insufficient combustion air supply.

BACKDRAFT PROBLEMS

A hot BACKDRAFT flowing out of the draft hood opening may be caused by cold outside air flowing down the vent, thus preventing the flue gas from exhausting. This may be due to improper vent termination, wind effects caused by nearby walls or trees, or an extreme indoor/outdoor temperature differential that causes cold air to flow down the vent. Mechanical fans or fireplaces may also serve to draw cold air down the vent, particularly in a very tightly constructed building.

A hot BACKDRAFT may also occur when a fan-assisted appliance and a natural draft appliance are common vented. If the common vent is undersized, the pressure from the fan-assisted draft may force the flue products to flow down and out at the draft hood appliance.

In a similar fashion, cold backdraft may occur when the appliance is not operating. This is normally due to extreme indoor/outdoor temperature differential, windy conditions, or mechanical fans or fireplaces.

LEAKAGE PROBLEMS

Normally, flue gas leakage at pipe joints and elbow gores is not a problem since the vent on a natural draft or fan-assisted Category I appliance operates under negative pressure, and therefore, any flow which might occur would be air flowing into the vent, as opposed to gas leaking out. If the vent is undersized, has too many elbows, tees, or

other restrictions, is too short in height, or is installed with a non-listed, restricted vent cap, it is possible to experience leakage. Obviously, any leakage of flue gas should be corrected immediately by increasing the vent size or height, or by identifying and correcting the source of the problem.

It should also be noted that Type-B Gas Vent is not an air tight vent system and should not be used to vent Category III or IV type appliances which operate under positive pressure.

As discussed throughout this handbook, modern high efficiency gas appliances have a greater tendency to form condensation with less heat being lost up the flue. If condensation does occur, it may leak out at pipe joints, fittings, and elbow gores. Since this can result in major damage to ceilings and walls, it is important to pay attention to the sizing and vent requirements contained in this handbook. Long runs of single-wall connectors, particularly through unheated attics and other spaces, may result in serious leakage problems.

Attempts to vent Category IV type appliances, which produce substantial quantities of condensate, with Type-B Gas Vent and single-wall galvanized connectors is strictly prohibited and will result in very serious water leakage as well as creating a safety hazard due to flue gas leakage. Category IV type appliances must be vented with PVC plastic pipe and fittings in accordance with the appliance manufacturers installation instructions.

Examples

SINGLE APPLIANCE VENTING TABLES

EXAMPLE 1:

Single Draft-Hood Equipped Appliance

Suppose that an installer has a 120,000 BTU input appliance with a 5-inch diameter draft hood outlet that needs to be vented into a 10-foot high Type-B vent system. What size vent should be used assuming (a) a 5-foot lateral single-wall metal vent connector is used with two 90° elbows, (b) a 5-foot lateral single-wall metal vent connector is used with three 90° elbows in the vent system?

Solution

Table 2 should be used to solve this problem because single-wall metal vent connectors are being used with a Type-B vent: Refer to Figure 85.

A. Read down the first column in Table 2 until the row associated with 10-foot height and 5-foot lateral is found. Read across this row until a vent capacity greater than 120,000 BTU is located in the columns labeled NAT Max for draft hood-equipped appliances. In this case, a 5-inch diameter vent has a capacity of 122,000 BTU and may be used for this application.

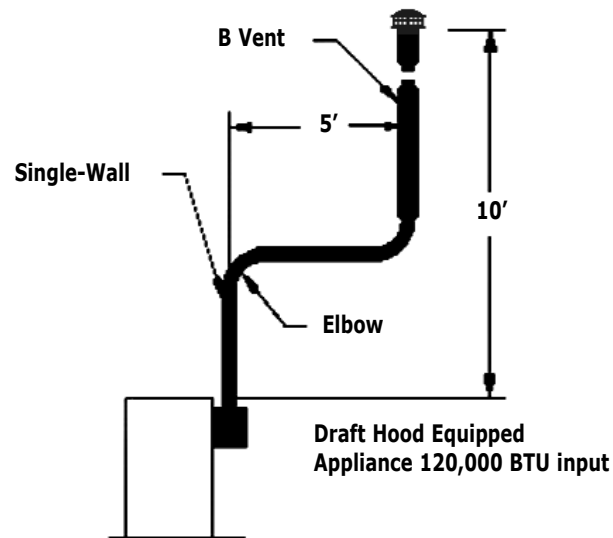
B. If three 90° elbows are used in the vent system, then the maximum vent capacity listed in the tables must be reduced by 10%. This implies that the 5-inch diameter vent has an adjusted capacity of only 110,000 BTU. In this case, the vent system must be increased to 6 inches in diameter. See calculations below:

$$122,000 \times .90 = 110,000 \text{ for 5-inch vent}$$

From Table 2 - Select 6-inch vent

$186,000 \times .90 = 167,000$ This is greater than the required 120,000, therefore, use a 6-inch vent and connector when three elbows are used.

Figure 85.

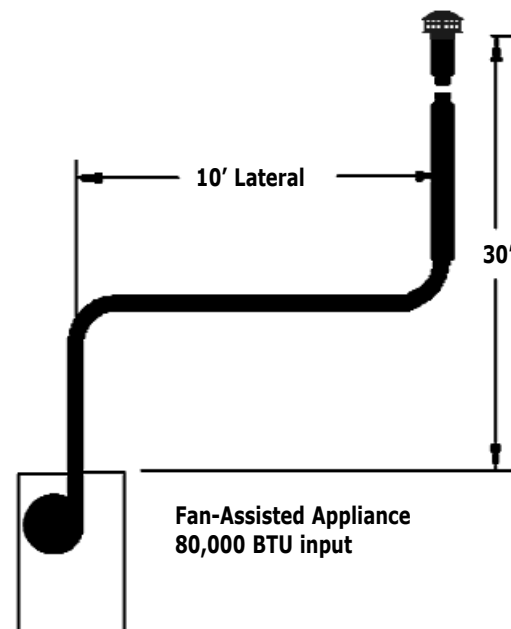


EXAMPLE 2:

Single Fan-Assisted Appliance

Suppose an installer has an 80,000 BTU input fan-assisted appliance that must be installed using 10 feet of lateral connector attached to a 30-foot high Type-B vent. Two 90° elbows are needed for the installation. Can a single-wall metal vent connector be used for this application?

Figure 86.



Solution

Table 2 refers to the use of single-wall metal vent connectors with Type-B vent. In the first column, find the row associated with a 30-foot height and a 10-foot lateral. Read across this row looking at the FAN Min and FAN Max columns, to find that a 3-inch diameter single-wall metal connector vent is not recommended. Moving to the next larger size single-wall connector (4") we find that a 4-inch diameter single-wall metal connector has a recommended minimum vent capacity of 91,000 BTU and a recommended maximum vent capacity of 144,000 BTU. The 80,000 BTU fan-assisted appliance is outside this range, so we conclude that a single-wall metal vent connector cannot be used to vent this appliance using 10 feet of lateral for the connector.

However, we see that if the 80,000 BTU input appliance could be moved to within 5 feet of the vertical vent, then a 4-inch single-wall metal connector could be used to vent the appliance. Table 2 shows the acceptable range of vent capacities for a 4-inch vent with 5 feet of lateral to be between 72,000 BTU and 157,000 BTU. If the appliance cannot be moved closer to the vertical vent, then Type-B vent could be used as the connector material. In this case, Table 1 shows that for a 30-foot high vent with 10 feet of lateral, the acceptable range of vent capacities for a 4-inch diameter vent attached to a fan-assisted appliance are between 37,000 BTU and 150,000 BTU.

EXAMPLE 3:

Common Venting Two Draft Hood Appliances

Suppose a 35,000 BTU water heater is to be common vented with a 150,000 BTU furnace using a common vent with a total height of 30 feet. The connector rise is 2 feet for the water heater and 3 feet for the furnace. Assume single-wall metal connectors will be used with Type-B vent. What size connectors and combined vent should be used in this installation?

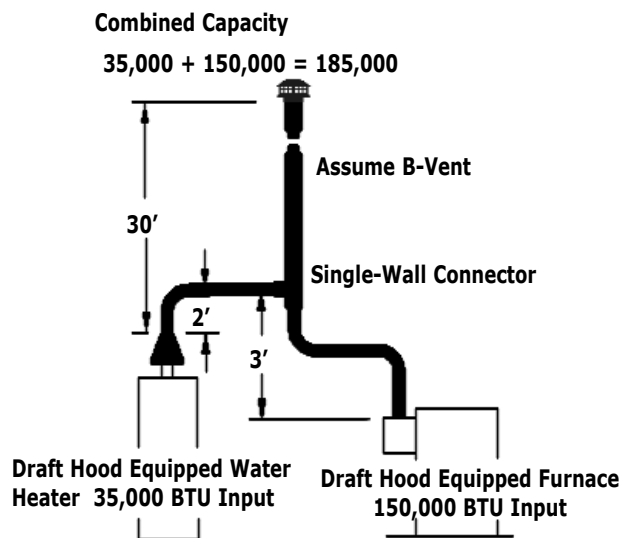
Solution

Table 4 should be used to size single-wall metal vent connectors attached to Type-B vertical vent. In the vent connector capacity Table 4, find the row associated with a 30-foot vent height. For a 2-foot rise on the vent connector for the water heater, read the shaded columns for draft hood-equipped appliances to find that a 3-inch diameter vent connector has a capacity of 37,000 BTU's.

Therefore, a 3-inch single-wall metal vent connector may be used with the water heater. For a draft hood-equipped furnace with a 3-foot rise, read across the appropriate row to find that a 5-inch diameter vent connector has a maximum capacity of 120,000 BTU (which is too small for the furnace) and a 6-inch diameter vent connector has a maximum capacity 172,000 BTU. Therefore, a 6-inch diameter vent connector should be used with the 150,000 BTU furnace.

For the capacity of the combined vent, the lower portion of Table 4 should be used. The combined vent capacity required is 185,000 BTU. Table 4 shows that the combined vent capacity of a 6-inch diameter vent with a 30-foot vent height is 257,000 BTU. This is more than adequate to handle the 35,000 BTU input water heater and the 150,000 BTU input furnace.

Figure 88.



EXAMPLE 4:

Common Venting a Draft Hood Water Heater with a Fan-Assisted Furnace

Figure 89.

In this case, a 35,000 BTU input draft hood-equipped water heater with a 2-foot connector rise is to be common vented with a 100,000 BTU fan-assisted furnace with a 3-foot rise of Type-B vent. What are other recommended vent diameters for each connector and the common vent?

Solution

Water Heater Vent Connector Diameter.

Let us assume the installer would like to use a single-wall metal vent connector.

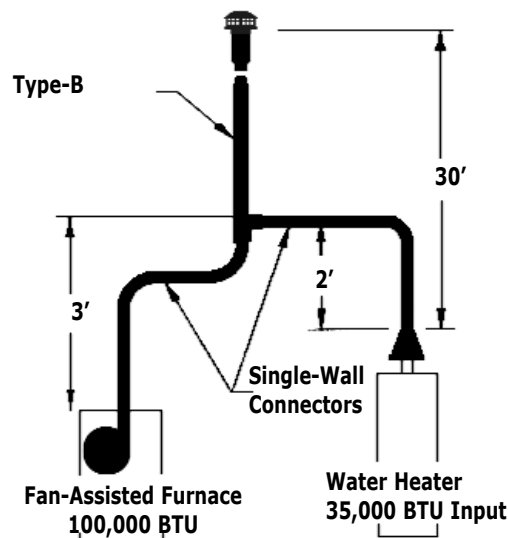
Using Table 4, Vent Connector Capacity, read down the Total Vent Height column

to 30 feet and read across the 2-foot Connector Rise row to the first BTU rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3-inch vent connector has a maximum input rating of 37,000 BTU. Since this is greater than the water heater input rating, a 3-inch vent connector is adequate. Furthermore, since the water heater is equipped with a draft hood, there are no minimum input rating restrictions.

Furnace Vent Connector Diameter. Again, let us assume the installer would like to use a single-wall metal vent connector. Using Table 4, Vent Connector Capacity, read down the Total Vent Height column to 30 feet and across the 3-foot Connector Rise row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a BTU rating greater than the furnace input rating. The 4-inch vent connector has a maximum input rating of 119,000 BTU and a minimum input reading of 85,000 BTU. The 100,000 BTU furnace in this example falls within this range, so a 4-inch connector is adequate. If the furnace would have had an input rating of 80,000 BTU, then a Type-B vent connector would have to be used in order to meet the minimum capacity limit.

Common Vent Diameter. The total input to the common vent is 135,000 BTU. Using Table 4, Common Vent Capacity, read down the Total Vent Height column to 30 feet and across this row to find the smallest vent diameter in the FAN + NAT column that has a BTU rating equal to or greater than 135,000 BTU. The 4-inch common vent has a capacity of 132,000 BTU and the 5-inch common vent has a capacity of 202,000 BTU. Therefore, the 5-inch common should be used in this example.

Summary. In this example, the installer may use a 3-inch diameter, single-wall metal vent connector for the water heater and a 4-inch diameter, single-wall metal vent connector for the furnace. The common vent should be 5-inch diameter Type-B vent.



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WARNING: The venting requirements and sizing tables contained in this handbook apply only to Category I natural draft and fan-assisted gas appliances. At no time should a venting system for a listed Category II, III, or IV appliance be sized with these tables

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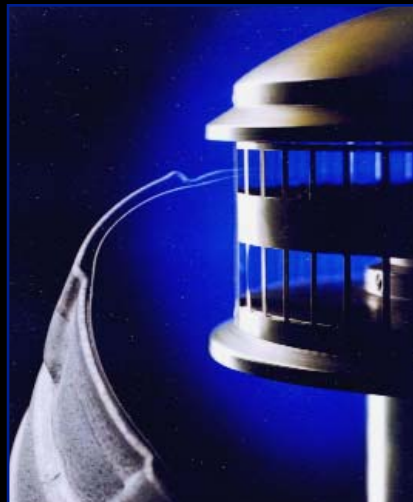
Mr. Townsend holds several patents in the field of venting. He has served on the Board of Directors of the Gas Appliance Manufacturer's Association (GAMA), past Chairman of the GAMA Gas Vent Division, and has served on the National Chimney Sweep Guild Technical Committee. Mr. Townsend has played an active role in the process of developing new industry standards for venting of both gas and woodburning appliances.

Mr. Townsend was appointed President of Simpson Dura-Vent in 1984. Prior to 1984, Mr. Townsend was with the Simpson Strong Tie Company, the leader in wood to wood metal connectors for the framing of buildings, and previously served as Chief Metallurgist of a division of Ingersoll Rand, a world-wide machinery manufacturer.



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