

CHAPTER 5

WATER HEATERS

Part I

501.0 General.

The regulations of this chapter shall govern the construction, location, and installation of fuel-burning and other water heaters heating potable water, together with all chimneys, vents, and their connectors. The minimum capacity for water heaters shall be in accordance with the first hour rating listed in Table 5-1. All design, construction, and workmanship shall be in conformity with accepted engineering practices, manufacturer's installation instructions, and applicable standards and shall be of such character as to secure the results sought to be obtained by this code. No water heater shall be hereinafter installed that does not comply in all respects with the type and model of each size thereof approved by the Authority Having Jurisdiction. A list of accepted gas equipment standards is included in Table 14-1.

502.0 Definitions.

502.1 Appliance Categorized Vent Diameter/Area.

The minimum vent area/diameter permissible for Category I appliances to maintain a nonpositive vent static pressure when tested in accordance with nationally recognized standards. [NFPA 54:3.3.7]

502.2 Chimney. (See also Gas Vent, and Venting System.) One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere. [NFPA 54: 3.3.17]

502.3 Chimney, Factory-Built. A chimney composed of listed factory-built components assembled in accordance with the terms of listing to form the completed chimney. [NFPA 54: 3.3.17.2]

502.4 Chimney, Masonry. A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced portland cement concrete, lined with suitable chimney flue liners. [NFPA 54: 3.3.17.3]

502.5 Chimney, Metal. A field-constructed chimney of metal. [NFPA 54: 3.3.17.4]

502.6 Combustible Material. As pertaining to materials adjacent to or in contact with heat-producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts, shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered. [NFPA 54: 3.3.65.1]

502.7 Direct-Vent Appliances. Appliances that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged to the outside atmosphere. [NFPA 54: 3.3.6.3]

502.8 Flue Collar. That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system. [NFPA 54: 3.3.45]

502.9 Gas Vent, Type B. A vent for venting-listed gas appliances with draft hoods and other Category I appliances listed for use with Type B gas vents. [NFPA 54: 3.3.105.2.2]

502.10 Gas Vent, Type L. A vent for venting appliances listed for use with Type L vents and appliances listed for use with Type B gas vents. [NFPA 54: 3.3.105.2.4]

502.11 Indirect-Fired Water Heater. A water heater consisting of a storage tank equipped with an internal or external heat exchanger used to transfer heat from an external source to heat potable water. The storage tank may contain heated potable water or water supplied from an external source, such as a boiler.

502.12 Vent. A passageway used to convey flue gases from gas utilization equipment or their vent connectors to the outside atmosphere. [NFPA 54: 3.3.105]

502.13 Vent Connector. The pipe or duct that connects a fuel-gas-burning appliance to a vent or chimney. [NFPA 54: 3.3.106]

TABLE 5-1¹ FIRST HOUR RATING

Number of Bathrooms	1 to 1.5			2 to 2.5				3 to 3.5			
	1	2	3	2	3	4	5	3	4	5	6
Number of Bedrooms											
First Hour Rating, ² Gallons	42	54	54	54	67	67	80	67	80	80	80

Note:

¹ The first hour rating is found on the "Energy Guide" label.

² Non-storage and solar water heaters shall be sized to meet the appropriate first hour rating as shown in the table.

502.14 Venting System. A continuous open passageway from the flue collar or draft hood of a gas-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases. [NFPA 54: 3.3.98.7]

502.15 Water Heater. An appliance for supplying hot water for domestic or commercial purposes. [NFPA 54: 3.3.55.7]

503.0 Permits.

It shall be unlawful for any person to install, remove, or replace or cause to be installed, removed, or replaced any water heater without first obtaining a permit from the Authority Having Jurisdiction to do so.

504.0 Inspection.

504.1 Inspection of Chimneys or Vents. This inspection shall be made after all chimneys, vents, or parts thereof, authorized by the permit, have been installed and before any such vent or part thereof has been covered or concealed.

504.2 Final Water Heater Inspection. This inspection shall be made after all work authorized by the permit has been installed. The Authority Having Jurisdiction will make such inspection as deemed necessary to be assured that the work has been installed in accordance with the intent of this code. No equipment or part thereof shall be covered or concealed until the same has been inspected and approved by the Authority Having Jurisdiction.

505.0 Water Heater Requirements.

505.1 Location. Water heater installations in bedrooms and bathrooms shall comply with one of the following [NFPA 54: 10.28.1]:

- (1) Fuel-burning water heaters may be installed in a closet located in the bedroom or bathroom provided the closet is equipped with a listed, gasketed door assembly and a listed self-closing device. The self-closing door assembly shall meet the requirements of Section 505.1.1. The door assembly shall be installed with a threshold and bottom door seal and shall meet the requirements of Section 505.1.2. All combustion air for such installations shall be obtained from the outdoors in accordance with Section 507.4. The closet shall be for the exclusive use of the water heater.
- (2) Water heater shall be of the direct vent type. [NFPA 54:10.28.1.2]

505.1.1 Self-Closing Doors. Self-closing doors shall swing easily and freely and shall be

equipped with a self-closing device to cause the door to close and latch each time it is opened. The closing mechanism shall not have a hold-open feature. [NFPA 80:2-1.4.1]

505.1.2 Gasketing. Gasketing on gasketed doors or frames shall be furnished only in accordance with the published listings of the doors, frame, or gasketing material manufacturer.

Exception: Where acceptable to the Authority Having Jurisdiction, gasketing of noncombustible or limited-combustible material (see NFPA 220 Standard on Types of Building Construction) shall be permitted to be applied to the frame, provided closing and latching of the door are not inhibited. [NFPA 80:2-4.8]

505.2 Water heaters of other than the direct-vent type shall be located as close as practical to the chimney or gas vent. [NFPA 54:9.28.1.2]

505.3 Clearance.

505.3.1 The clearances shall not be such as to interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. Listed water heaters shall be installed in accordance with their listings and the manufacturers' instructions. [NFPA 54:10.28.2.1]

505.3.2 Unlisted water heaters shall be installed with a clearance of 12 inches (300 mm) on all sides and rear. Combustible floors under unlisted water heaters shall be protected in an approved manner. [NFPA 54:10.28.2.2]

505.4 Pressure-Limiting Devices. A water heater installation shall be provided with overpressure protection by means of an approved, listed device, installed in accordance with the terms of its listing and the manufacturer's instructions. [NFPA 54: 10.28.3]

505.5 Temperature-Limiting Devices. A water heater installation or a hot water storage vessel installation shall be provided with overtemperature protection by means of an approved, listed device installed in accordance with the terms of its listing and the manufacturer's instructions. [NFPA 54: 10.28.4]

505.6 Temperature, Pressure, and Vacuum Relief Devices. The installation of temperature, pressure, and vacuum relief devices or combinations thereof, and automatic gas shutoff devices, shall be installed in accordance with the terms of their listings and the manufacturers' instructions. A shutoff valve shall not be placed between the relief valve and the water heater or on discharge pipes between such valves and the atmosphere. The hourly Btu discharge capacity or the rated steam relief capacity of the device shall not be less than the input rating of the water heater. [NFPA 54: 10.28.5]

506.0 Oil-Burning and Other Water Heaters.

→ **506.1** Water heaters deriving heat from fuels or types of energy other than gas shall be constructed and installed in accordance with approved standards.

→ Vents or chimneys for such appliances shall be approved types. An adequate supply of air for combustion and for adequate ventilation of heater rooms or compartments shall be provided. Each such appliance shall be installed in a location approved by the Authority Having Jurisdiction and local and state fire-prevention agencies.

506.2 All storage-type water heaters and hot water boilers deriving heat from fuels or types of energy other than gas, shall be provided with, in addition to the primary temperature controls, an overtemperature safety protection device constructed, listed, and installed in accordance with nationally recognized applicable standards for such devices and a combination temperature and pressure-relief valve.

506.3 Oil-fired water heaters shall be installed in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment*.

506.4 Indirect-Fired Water Heaters

506.4.1 Indirect-fired water heaters shall conform to applicable sections of the ASME Boiler and Pressure Vessel Code, or to one of the other applicable standards shown in Table 14-1. Each water heater shall bear a label in accordance with ASME requirements, or an approved testing agency, certifying and attesting that such equipment has been tested and inspected and meets the requirements of the applicable standards or code.

506.4.2 Indirect-fired water heater that incorporate a single-wall heat exchanger shall meet all of the following requirements:

- (1) Connected to a low-pressure hot water boiler limited to a maximum of 30 psig by an approved safety or relief valve.
- (2) Heater transfer medium is either potable water or contains fluids having a toxicity rating or Class of 1.
- (3) Bear a label with the word "Caution," followed by the following statements:
 - (a) The heat-transfer medium must be water or other nontoxic fluid having a toxic rating or Class of 1 as listed in *Clinical Toxicology of Commercial Products*, 5th edition.
 - (b) The pressure of the heat-transfer medium must be limited to a maximum of 30 psig by an approved safety or relief valve.

Note: The word "Caution" and the statements in letters having a minimum uppercase height of 0.120 inch (3.05 mm). The minimum vertical spacing between lines of type shall be 0.046 inch (1.17 mm). Lowercase letters shall be

compatible with the uppercase letter size specification.

507.0 Air for Combustion and Ventilation.**507.1 General.**

507.1.1 Air for combustion, ventilation, and dilution of flue gases for gas utilization equipment installed in buildings shall be obtained by application of one of the methods covered in Sections 507.2.1 through 507.7. Gas utilization equipment of other than natural draft and Category I vented appliances shall be provided with combustion, ventilation, and dilution air in accordance with the equipment manufacturer's instructions. Where infiltration does not provide the necessary air, outdoor air shall be introduced in accordance with methods covered in Sections 507.4 through 507.7. [NFPA 54:9.3.1.1]

Exception No. 1: This provision shall not apply to direct-vent appliances. [NFPA 54-2002:8.3.1.1]

Exception No. 2: Type 1 clothes dryers that are provided with make-up air in accordance with section NFPA 54:10.4.3.

507.1.1.1 Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel gases. [NFPA 54:3.3.18]

507.1.1.2 Clothes Dryer, Type 1. Primarily used in family living environment. May or may not be coin-operated for public use. [NFPA 54:3.3.18.1]

507.1.1.3 Exhausting to the Outdoors. Type 1 and Type 2 clothes dryers shall be exhausted to the outside air. [NFPA 54:10.4.2]

507.1.1.4 Provisions for Make-Up Air. Make-up air shall be provided for Type 1 clothes dryers in accordance with the manufacturers' installation instructions. [NFPA 54:10.4.3.1]

507.1.2 Gas appliances of other than natural draft design and other than Category I vented appliances shall be provided with combustion, ventilation, and dilution air in accordance with the appliance manufacturer's instructions. [NFPA 54:9.3.1.2]

507.1.3 Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment served so as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:9.3.1.4]

507.1.4 Makeup air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers, and fireplaces shall be considered in determining the adequacy of a

space to provide combustion air requirements. [NFPA 54:9.3.1.5]

507.2 Indoor Combustion Air. The required volume of indoor air shall be determined in accordance with Sections 507.2.1 or 507.2.2 except that where the air infiltration rate is known to be less than 0.40 ACH, Section 507.2.2 shall be used. The total required volume shall be the sum of the required volume calculated for all appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with Section 507.3 are considered a part of the required volume. [NFPA 54:9.3.2]

507.2.1 Standard Method. The minimum required volume shall be 50 cubic feet per 1,000 Btu/hour (4.8 m³/kW). [NFPA 54:9.3.2.1]

507.2.2 Known Air Infiltration Rate Method. Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows [NFPA 54:9.3.2.2]:

(1) For appliances having other than fan-assisted, combustion systems: calculate using Equation 5-1 but no smaller than 35 cubic feet per 1,000 Btu/hour (3.4 m³/kW). [NFPA 54:9.3.2.2(1)]

(2) For fan-assisted combustion system appliances, calculate using Equation 5-2 but no smaller than 25 cubic feet per 1,000 Btu/hour (2.4 m³/kW). [NFPA 54:9.3.2.2(2)]

Equation 5-1:

Required Volume $I_{other} > (21 \text{ ft}^3 / \text{ACH}) \times (I_{other} / 1,000 \text{ Btu/h})$

Equation 5-2:

Required Volume $I_{fan} > (15 \text{ ft}^3 / \text{ACH}) \times (I_{fan} / 1,000 \text{ Btu/h})$

Where:

I_{other} = All Appliances other than Fan-Assisted Input in Btu/hour

I_{fan} = Fan-Assisted Appliance Input in Btu/hour
ACH = Air Change per Hour (Percent of volume of space exchanged per hour, expressed as a decimal)

507.3 Indoor Opening Size and Location. Openings used to connect indoor spaces shall be sized and located in accordance with the following [NFPA 54:9.3.2.3]:

(1) *Combining spaces on the same story.* Each opening shall have a minimum free area of 1 in.²/1,000 Btu/h (2200 mm²/kW) of the total input rating of all gas utilization equipment in the space, but not less than 100 in.² (0.06 m²). One opening shall commence

within 12 inches (300 mm) of the top, and one opening shall commence within 12 inches (300 mm) of the bottom of the enclosure [see Figure 5-12]. The minimum dimension of air openings shall be not less than 3 inches (80mm). [NFPA 54:9.3.2.3(1)]

(2) *Combining spaces in different stories.* The volumes of spaces in different stories shall be considered as communicating spaces where such spaces are connected by one or more openings in doors or floors having a total minimum free area of 2 in.²/1,000 Btu/h (4,400 mm²/kW) of total input rating of all gas utilization equipment. [NFPA 54:8.3.2.3(2)]

507.4 Outdoor Combustion Air. Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with methods Sections 507.4.1 or 507.4.2. The minimum dimension of air openings shall not be less than 3 inches (80 mm). [NFPA 54:9.3.3]

507.4.1 Two Permanent Openings Method:

Two permanent openings, one commencing within 12 inches (300 mm) of the top and one commencing within 12 inches (300 mm) of the bottom of the enclosure shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors as follows. [See Figure 5-7.] [NFPA 54:9.3.3.1]

(1) Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 in.²/4000 Btu/h (550 mm²/kW) of total input rating of all equipment in the enclosure. [See Figures 5-8 and 5-9.] [NFPA 54:9.3.3.1(1)]

(2) Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 in.²/2,000 Btu/h (1,100 mm²/kW) of total input rating of all equipment in the enclosure. [See Figure 5-10] [NFPA 54:9.3.3.1(2)]

507.4.2 One Permanent Opening Method: One permanent opening, commencing within 12 inches (300 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least 1 inch (25 mm) from the sides and back and 6 inches (160 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors [see Figure 5-11] and shall have a minimum free area of the following [NFPA 54:9.3.3.2]:

(1) 1 in.²/3000 Btu/h (700 mm²/kW) of the

total input rating of all equipment located in the enclosure, and [NFPA 54:9.3.3.2(1)]

- (2) Not less than the sum of the areas of all vent connectors in the space. [NFPA 54: 9.3.3.2(2)]

507.5 Combination Indoor and Outdoor Combustion Air. The use of a combination of indoor and outdoor combustion air shall be in accordance with Sections 507.5.1, 507.5.2 and 507.5.3 [see example calculation in NFPA 54 Annex J and this chapter – Part II] [NFPA 54:9.3.4].

507.5.1 Indoor Openings. Where used, openings connecting the interior spaces shall comply with Section 507.3. [NFPA 54:9.3.4(1)]

507.5.2 Outdoor openings shall be located in accordance with Sections 507.4.1 or 507.4.2. [NFPA 54:9.3.4(2)]

507.5.3 Outdoor Openings Size. The outdoor openings size shall be calculated in accordance with the following [NFPA 54:9.3.4(3)]:

- (1) The ratio of interior spaces shall be the available volume of all communicating spaces divided by the required volume.
- (2) The outdoor size reduction factor shall be 1 minus the ratio of interior spaces.
- (3) The minimum size of outdoor openings shall be the full size of outdoor openings calculated in accordance with Sections 507.4.1 or 507.4.2, multiplied by the reduction factor. The minimum dimension of air openings shall not be less than 3 inches (80 mm). [NFPA 54:8.3.4(3)(c)]

507.6 Engineered Installations. Engineered combustion air installations shall provide an adequate supply of combustion, ventilation, and dilution air and shall be approved by the Authority Having Jurisdiction. [NFPA 54: 9.3.5]

507.7 Mechanical Combustion Air Supply. Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from outdoors at the minimum rate of 0.35 feet³/min per 1,000 Btu/h (0.034 m³/min per kW) for all appliances located within the space.

507.7.1 Where exhaust fans are installed, additional air shall be provided to replace the exhausted air. [NFPA 54:9.3.6.1]

507.7.2 Each of the appliances served shall be interlocked to the mechanical air supply system to prevent main burner operation where the mechanical air supply system is not in operation. [NFPA 54:9.3.6.2]

507.7.3 Where combustion air is provided by the building's mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air. [NFPA 54: 9.3.6.3]

507.8 Louvers Grilles and Screens.

(A) Louvers and Grilles. The required size of openings for combustion, ventilation, and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area are not known, it shall be assumed that wood louvers will have 25 percent free area and metal louvers and grilles will have 75 percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. [NFPA 54:9.3.7.1]

(B) Screens. Screens shall not be smaller than 1/4-inch mesh. [NFPA 54:9.3.7.2]

(C) Motorized louvers shall be interlocked with the equipment so they are proven in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting should the louver fail to open during burner start-up and to shut down the main burner if the louvers close during burner operation. [NFPA 54: 9.3.7.3]

507.9 Combustion Air Ducts. Combustion air ducts shall comply with the following:

- (1) Ducts shall be of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity. [NFPA 54:9.3.8.1]

Exception: Within dwelling units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one fireblock is removed.

- (2) Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:9.3.8.2]
- (3) Ducts shall serve a single space. [NFPA 54:9.3.8.3]
- (4) Ducts shall not service both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air. [NFPA 54:9.3.8.4]
- (5) Ducts shall not be screened where terminating in an attic space. [NFPA 54:9.3.8.5]
- (6) Intakes for combustion air ducts located exterior to the building shall have the lowest side of the combustion air intake openings located at least 12 inches (300 mm) vertically from the adjoining grade level.

- (7) Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air. [NFPA 54:9.3.8.6]
- (8) The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue, metal or factory-built chimney, shall not be used to supply combustion air [NFPA 54:9.3.8.7], unless it is listed and shown in the manufacturer's installation instructions.

508.0 Other Water Heater Installation Requirements.

508.1 The Authority Having Jurisdiction shall have the authority to require the use of an approved dielectric insulator on the water piping connections of water heaters and related water heating equipment.

508.2 Protection from Seismic Damage. In seismic design categories C, D, E, and F water heaters shall be anchored or strapped to resist horizontal displacement due to earthquake motion. Strapping shall be at points within the upper one third (1/3) and lower one-third (1/3) of its vertical dimensions. At the lower point, a minimum distance of four (4) inches (102 mm) shall be maintained above the controls with the strapping.

508.2.1 [HCD 1, HCD 2, and SFM] Protection from seismic damage.*** Water heaters shall be anchored to resist horizontal displacement due to earthquake motion. Strapping shall be at points within the upper one third (1/3) and lower one-third (1/3) of its vertical dimensions. At the lower point, a minimum distance of four (4) inches (102 mm) shall be maintained above the controls with the strapping.

Note: [HCD 1 & HCD 2] Reference Health and Safety Code Section 19211(a) which addresses new, replacement, and existing water heaters.

Note: [SFM] The applicable subsection of Health and Safety Code section 19211(a) which addresses new, replacement, and existing water heaters is repeated here for clarity and reads as follows:

Section 19211(a) Notwithstanding Section 19100, all new and replacement water heaters, and all existing residential water heaters shall be braced, anchored, or strapped to resist falling or horizontal displacement due to earthquake motion. At a minimum, any water heater shall be secured in accordance with the California Plumbing Code, or modifications made thereto by a city county, or city and county pursuant to Section 17958.5.

508.3 A water heater supported from the ground shall rest on level concrete or other approved base extending not less than three (3) inches (76 mm) above the adjoining ground level.

508.4 When a water heater is located in an attic, attic-ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly where damage may result from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater with a minimum three-quarter (3/4) inch (20 mm) diameter drain to an approved location.

508.5 Relief Valve Discharge.

Discharge from a relief valve into a water heater pan shall be prohibited.

508.6 Added or Converted Equipment. When additional or replacement equipment is installed or an appliance is converted to gas from another fuel, the location in which the equipment is to be operated shall be checked to verify the following [NFPA 54:9.1.2]:

508.6.1 Air for combustion and ventilation is provided where required, in accordance with the provisions of Section 507.0. Where existing facilities are not adequate, they shall be upgraded to Section 507.0 specifications [NFPA 54:9.1.2(1)].

508.6.2 The installation components and equipment meet the clearances to combustible material provisions of NFPA 54:9.2.2. It shall be determined that the installation and operation of the additional or replacement equipment does not render the remaining equipment unsafe for continued operation. [NFPA 54:9.1.2(2)]

(The following reference was extracted from NFPA 54.)

9.2.2 Clearance to Combustible Materials. Gas utilization equipment and their vent connectors shall be installed with clearances from combustible material so their operation will not create a hazard to persons or property. Minimum clearances between combustible walls and the back and sides of various conventional types of equipment and their vent connectors are specified in Chapters 9 and 10. (Reference can also be made to NFPA 211, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.)

508.6.3 The venting system is constructed and sized in accordance with the provisions of this chapter. Where the existing venting system is not adequate, it shall be upgraded to comply with this chapter. [NFPA 54: 9.1.2(3)]

508.7 Types of Gases. It shall be determined whether the gas-utilization equipment has been designed for use with the gas to which it will be connected. No attempt shall be made to convert the equipment from the gas specified on the rating plate for use with a different gas without consulting the installation instructions, the serving gas supplier, or the equipment manufacturer for complete instructions. [NFPA 54: 9.1.3]

508.8 Safety Shutoff Devices for Unlisted LP-Gas Equipment Used Indoors. Unlisted gas utilization equipment for use with undiluted liquefied petroleum gases and installed indoors shall be equipped with safety shutoff devices of the complete shutoff type. [NFPA 54: 9.1.4]

508.9 Use of Air or Oxygen Under Pressure. Where air or oxygen under pressure is used in connection with the gas supply, effective means such as a back-pressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. Where oxygen is used, installation shall be in accordance with NFPA 51, *Standard for the Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes*. [NFPA 54: 9.1.5]

508.10 Protection of Gas Equipment from Fumes or Gases Other than Products of Combustion. Non-direct vent-type gas appliances installed in beauty shops, barbershops, or other facilities where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used shall be located in an equipment room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors. Direct vent equipment shall be installed in accordance with the appliance manufacturer's installation instructions. [NFPA 54: 9.1.6.2]

508.11 Process Air. In addition to air needed for combustion in commercial or industrial processes, process air shall be provided as required for cooling of equipment or material, controlling dew point, heating, drying, oxidation, dilution, safety exhaust, odor control, air for compressors, and for comfort and proper working conditions for personnel. [NFPA 54: 9.1.7]

508.12 Building Structural Members.

508.12.1 Structural members of a building shall not pass through gas utilization equipment having an operating temperature in excess of 500°F (260°C). [NFPA 54:9.1.8.1]

508.12.2 Structural members passing through gas utilization equipment having an operating temperature of 500°F (260°C) or less shall be of noncombustible material. Building columns, girders, beams, or trusses shall not be installed within equipment, unless insulation and ventilation are provided to avoid all deterioration in strength and linear expansion of the building structure in either a vertical or a horizontal direction. [NFPA 54:9.1.8.2]

508.12.3 Gas utilization equipment shall be furnished either with load-distributing bases or with a sufficient number of supports to prevent damage to either the building structure or equipment. [NFPA 54:9.1.8.3]

508.12.4 At the locations selected for installation of gas utilization equipment, the dynamic and

static load-carrying capacities of the building structure shall be checked to determine whether they are adequate to carry the additional loads. The equipment shall be supported and shall be connected to the piping so as not to exert undue stress on the connections. [NFPA 54:9.1.8.4]

508.13 Flammable Vapors. Gas appliances shall not be installed in areas where the open use, handling, or dispensing of flammable liquids occurs, unless the design, operation, or installation reduces the potential of ignition of the flammable vapors. Gas utilization equipment installed in compliance with Sections 508.14, 508.15, or 508.16 shall be considered to comply with the intent of this provision. [NFPA 54: 9.1.9]

508.14 Installation in Residential Garages.

- (1) Gas utilization equipment in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling unit shall be installed so that all burners and burner-ignition devices are located not less than 18 inches (450 mm) above the floor unless listed as flammable vapor ignition resistant. [NFPA 54:9.1.10.1]
- (2) Such equipment shall be located or protected so it is not subject to physical damage by a moving vehicle. [NFPA 54:9.1.10.2]
- (3) When appliances are installed in a separate, enclosed space having access only from outside of the garage, such equipment may be installed at floor level, providing the required combustion air is taken from the exterior of the garage. [NFPA 54: 9.1.10.3]

508.15 Installation in Commercial Garages.

508.15.1 Parking Structures. Gas utilization equipment installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A, *Standard for Parking Structures*. [NFPA 54:9.1.11.1]

508.15.2 Repair Garages. Gas utilization equipment installed in repair garages shall be installed in a detached building or room, separated from repair areas by walls or partitions, floors, or floor-ceiling assemblies that are constructed so as to prohibit the transmission of vapors and having a fire-resistance rating of not less than 1 hour, and that have no openings in the wall separating the repair area within 8 feet (2.5 m) of the floor. Wall penetrations shall be fire-stopped. Air for combustion purposes shall be obtained from outside the building. The heating room shall not be used for the storage of combustible materials. [NFPA 54:9.1.11.2]

Exception No. 1: Overhead heaters where installed not less than 8 ft (2.5 m) above the floor shall be permitted.

Exception No. 2: Heating equipment for vehicle repair areas where there is no dispensing or transferring of Class I or Class II flammable or combustible liquids or liquefied petroleum gas shall be installed in accordance with NFPA 30A, *Automotive and Marine Service Station Code*. [NFPA 54: 8.1.11.2]

508.16 Installation in Aircraft Hangars. Heaters in aircraft hangars shall be installed in accordance with NFPA 409, *Standard on Aircraft Hangars*. [NFPA 54: 9.1.12]

508.17 Gas Equipment Physical Protection. Where it is necessary to locate gas utilization equipment close to a passageway traveled by vehicles or equipment, guardrails or bumper plates shall be installed to protect the equipment from damage. [NFPA 54: 9.1.13]

508.18 Venting of Flue Gases. Gas utilization equipment shall be vented in accordance with the provisions of this chapter and NFPA 54, Chapter 10. [NFPA 54: 9.1.14]

508.19 Extra Device or Attachment. No device or attachment shall be installed on any gas utilization equipment that could in any way impair the combustion of gas. [NFPA 54: 9.1.15]

508.20 Adequate Capacity of Piping. When additional gas utilization equipment is being connected to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity. (See Section 1209.4.3.) Where inadequate, the existing system shall be enlarged as necessary, or separate gas piping of adequate capacity shall be run from the point of delivery to the equipment. [NFPA 54: 9.1.16]

508.21 Avoiding Strain on Gas Piping. Gas utilization equipment shall be supported and so connected to the piping as not to exert undue strain on the connections. [NFPA 54: 9.1.17]

508.22 Gas Appliance Pressure Regulators. Where the gas supply pressure is higher than that at which the gas utilization equipment is designed to operate or varies beyond the design pressure limits of the equipment, a gas appliance pressure regulator shall be installed. [NFPA 54: 9.1.18]

508.23 Venting of Gas Appliance Pressure Regulators. Venting of gas appliance pressure regulators shall comply with the following requirements [NFPA 54:9.1.19]:

508.23.1 Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the equipment, into the combustion chamber adjacent to a continuous

pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure. [NFPA 54:9.1.19(1)]

508.23.2 Vent limiting means shall be employed on listed gas appliance pressure regulators only. [NFPA 54:9.1.19(2)]

508.23.3 In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter. [NFPA 54:9.1.19(3)]

508.23.4 Under no circumstances shall a regulator be vented to the gas utilization equipment flue or exhaust system. [NFPA 54:9.1.19(4)]

508.23.5 In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined. [NFPA 54:9.1.19(5)]

508.23.6 Vent lines from a gas appliance pressure regulator and bleed lines from a diaphragm-type valve shall not be connected to a common manifold terminating in a combustion chamber. Vent lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54:9.1.19(6)]

508.24 Bleed Lines for Diaphragm-Type Valves. Bleed lines shall comply with the following requirements [NFPA 54:9.1.20]:

508.24.1 Diaphragm-type valves shall be equipped to convey bleed gas to the outside atmosphere or into the combustion chamber adjacent to a continuous pilot. [NFPA 54:9.1.20(1)]

508.24.2 In the case of bleed lines leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter. [NFPA 54:9.1.20(2)]

508.24.3 Bleed lines shall not terminate in the gas utilization equipment flue or exhaust system. [NFPA 54:9.1.20(3)]

508.24.4 In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed position

relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined. [NFPA 54:9.1.20(4)]

508.24.5 Bleed lines from a diaphragm-type valve and vent lines from a gas appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber. Bleed lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54:9.1.20(5)]

508.25 Combination of Equipment. Any combination of gas utilization equipment, attachments, or devices used together in any manner shall comply with the standards that apply to the individual equipment. [NFPA 54: 9.1.21]

508.26 Installation Instructions. The installing agency shall conform with the equipment manufacturer's recommendations in completing an installation. The installing agency shall leave the manufacturer's installation, operating, and maintenance instructions in a location on the premises where they will be readily available for reference and guidance for the Authority Having Jurisdiction, service personnel, and the owner or operator. [NFPA 54: 9.1.22]

508.27 Protection of Outdoor Equipment. Gas utilization equipment not listed for outdoor installation but installed outdoors shall be provided with protection to the degree that the environment requires. Equipment listed for outdoor installation shall be permitted to be installed without protection in accordance with the provisions of its listing. (See 9.2.1.) [NFPA 54: 9.1.23]

(The following references were extracted from NFPA 54.)

9.2 Accessibility and Clearance.

9.2.1 Accessibility for Service. All gas utilization equipment shall be located with respect to building construction and other equipment so as to permit access to the gas utilization equipment. Sufficient clearance shall be maintained to permit cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the equipment shall be floored.

509.0 Equipment on Roofs.

509.1 General.

- (1) Gas-utilization equipment on roofs shall be designed or enclosed so as to withstand climactic conditions in the area in which they are installed. Where enclosures are provided,

each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least a 30-inches (760mm) clearance between the entire service access panel(s) of the equipment and the wall of the enclosure. [NFPA 54:9.4.1.1]

- (2) Roofs on which equipment is to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load. [NFPA 54:9.4.1.2]
- (3) All access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54:9.4.1.3]

509.2 Installation of Equipment on Roofs.

- (1) Gas utilization equipment shall be installed in accordance with its listing and the manufacturer's installation instructions. [NFPA 54:9.4.2.1]
- (2) Equipment shall be installed on a well-drained surface of the roof. At least 6 feet (1.8m) of clearance shall be available between any part of the equipment and the edge of a roof or similar hazard, or rigidly fixed rails, guards, parapets, or other building structures at least 42 inches (1.1 m) in height shall be provided on the exposed side. [NFPA 54:9.4.2.2]
- (3) All equipment requiring an external source of electrical power for its operation shall be provided with (1) a readily accessible electrical disconnecting means within sight of the equipment that will completely de-energize the equipment, and (2) a 120-V ac grounding-type receptacle outlet on the roof adjacent to the equipment. The receptacle outlet shall be on the supply side of the disconnect switch. [NFPA 54:9.4.2.3]
- (4) Where water stands on the roof at the equipment or in the passageways to the equipment, or where the roof is of a design having a water seal, a suitable platform, walkway, or both shall be provided above the waterline. Such platforms or walkways shall be located adjacent to the equipment and control panels so that the equipment can be safely serviced where water stands on the roof. [NFPA 54: 9.4.2.4]

509.3 Access to Equipment on Roofs.

509.3.1 Gas utilization equipment located on roofs or other elevated locations shall be accessible. [NFPA 54:9.4.3.1]

509.3.2 Buildings more than 15 feet (4.6 m) in height shall have an inside means of access to the roof, unless other means acceptable to the Authority Having Jurisdiction are used. [NFPA 54:9.4.3.2]

509.3.3 The inside means of access shall be a

permanent, or fold-away inside stairway or ladder, terminating in an enclosure, scuttle, or trap door. Such scuttles or trap doors shall be at least 22 inches x 24 inches (560 mm x 610 mm) in size, shall open easily and safely under all conditions, especially snow; and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least 6 feet (1.8 m) of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards a minimum of 42 inches (1.1 m) in height shall be provided on the exposed side. Where parapets or other building structures are utilized in lieu of guards or rails, they shall be a minimum of 42 inches (1.1 m) in height. [NFPA 54:9.4.3.3]

509.3.4 Permanent lighting shall be provided at the roof access. The switch for such lighting shall be located inside the building near the access means leading to the roof. [NFPA 54: 9.4.3.4]

509.4 Appliances in Attics.

509.4.1 Attic Access. An attic in which an appliance is installed shall be accessible through an opening and passageway at least as large as the largest component of the appliance, and not less than 22 inches x 30 inches (560 mm x 760 mm). [NFPA 54:9.5.1]

509.4.2 Where the height of the passageway is less than 6 feet (1.8 m), the distance from the passageway access to the appliance shall not exceed 20 feet (6.1 m) measured along the centerline of the passageway. [NFPA 54:9.5.1.1]

509.4.3 The passageway shall be unobstructed and shall have solid flooring not less than 24 inches (610 mm) wide from the entrance opening to the appliance. [NFPA 54:9.5.1.2]

509.4.4 Work Platform. A level working platform not less than 30 inches (760 mm) by 30 inches (760 mm) shall be provided in front of the service side of the appliance. [NFPA 54:9.5.2]

509.4.5 Lighting and Convenience Outlet. A permanent 120-volt receptacle outlet and a lighting fixture shall be installed near the appliance. The switch controlling the lighting fixture shall be located at the entrance to the passageway. [NFPA 54:9.5.3]

510.0 Venting of Equipment.

510.1 General. This section recognizes that the choice of venting materials and the methods of installation of venting systems are dependent on the operating characteristics of the gas utilization equipment. The operating characteristics of vented

gas utilization equipment can be categorized with respect to (1) positive or negative pressure within the venting system, and (2) whether or not the equipment generates flue or vent gases that can condense in the venting system. See NFPA 54 Section 3.3 for the definition of these vented appliance categories. [NFPA 54:12.2]

510.2 Specification for Venting.

510.2.1 Connection to Venting Systems.

Except as permitted in Sections 510.2.2 through 510.2.6, all gas utilization equipment shall be connected to venting systems. [NFPA 54:12.3.1]

510.2.2 Equipment Not Required to Be Vented. The following equipment shall not be required to be vented [NFPA 54:12.3.2]:

510.2.2.1 Listed Ranges. [NFPA 54:12.3.2(1)]

510.2.2.2 Built-in Domestic Cooking Units Listed and Marked for Optional Venting. [NFPA 54:12.3.2(2)]

510.2.2.3 Listed Hot Plates and Listed Laundry Stoves. [NFPA 54:12.3.2(3)]

510.2.2.4 Listed Type 1 clothes dryers shall be exhausted to the outside air. [NFPA 54:12.3.2(4)]

510.2.2.5 A single listed booster-type (automatic instantaneous) water heater, when designed and used solely for the sanitizing rinse requirements of a dishwashing machine, provided that the equipment is installed with the draft hood in place and unaltered if a draft hood is required, in a commercial kitchen having a mechanical exhaust system; where installed in this manner, the draft hood outlet shall not be less than 36 inches (910 mm) vertically and 6 inches (150 mm) horizontally from any surface other than the equipment. [NFPA 54:12.3.2(5)]

510.2.2.6 Listed Refrigerators. [NFPA 54:12.3.2(6)]

510.2.2.7 Counter Appliances. [NFPA 54:12.3.2(7)]

510.2.2.8 Direct Gas-Fired Makeup Air Heaters. [NFPA 54:12.3.2(9)]

510.2.2.9 Other Equipment Listed for Unvented Use and Not Provided with Flue Collars. [NFPA 54:12.3.2(10)]

510.2.2.10 Specialized Equipment of Limited Input such as Laboratory Burners or Gas Lights. [NFPA 54:12.3.2(11)] Where any or all of this equipment in Sections 510.2.2.1 through 510.2.2.10 is installed so the aggregate input rating exceeds 20 Btu/h/ft³

(207 W/m³) of room or space in which it is installed, one or more shall be provided with venting systems or other approved means for removing the vent gases to the outside atmosphere so the aggregate input rating of the remaining unvented equipment does not exceed 20 Btu/h/ft³ (207 W/m³). Where the calculation includes the volume of an adjacent room or space, the room or space in which the equipment is installed shall be directly connected to the adjacent room or space by a doorway, archway, or other opening of comparable size that cannot be closed.

510.2.3 Ventilating Hoods. Ventilating hoods and exhaust systems shall be permitted to be used to vent gas utilization equipment installed in commercial applications (see Section 510.3.5) and to vent industrial equipment, particularly where the process itself requires fume disposal. [NFPA 54:12.3.3]

510.2.4 Well-Ventilated Spaces. The operation of industrial gas utilization equipment such that its flue gases are discharged directly into a large and well-ventilated space shall be permitted. [NFPA 54:12.3.4]

510.2.5 Direct-Vent Equipment. Listed direct-vent gas utilization equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturer's instructions, and Section 510.8(3) of this code. [NFPA 54:12.3.5]

510.2.6 Equipment with Integral Vents. Gas utilization equipment incorporating integral venting means shall be considered properly vented where installed in accordance with its listing, the manufacturer's instructions, and Sections 510.8.1 and 510.8.2 of this code. [NFPA 54:12.3.6]

510.3 Design and Construction.

510.3.1 Minimum Safe Performance. A venting system shall be designed and constructed so as to develop a positive flow adequate to remove flue or vent gases to the outside atmosphere.

510.3.2 Equipment Draft Requirements. A venting system shall satisfy the draft requirements of the equipment in accordance with the manufacturer's instructions. [NFPA 54:12.4.1]

510.3.3 Design and Construction. Gas utilization equipment required to be vented shall be connected to a venting system designed and installed in accordance with the provisions of Sections 510.4 through 510.15 of this code. [NFPA 54:12.4.2]

510.3.4 Mechanical Draft Systems.

510.3.4.1 Mechanical draft systems shall be listed and shall be installed in accordance with the terms of their listing and both the appliance and the mechanical draft system manufacturers' instructions. [NFPA 54:12.4.3.1]

510.3.4.2 Gas utilization equipment requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design. [NFPA 54:12.4.3.2]

Exception: Incinerators.

510.3.4.3 Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue or vent gases into a building. [NFPA 54:12.4.3.3]

510.3.4.4 Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure. [NFPA 54:12.4.3.4]

510.3.4.5 Where a mechanical draft system is employed, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the equipment for safe performance. [NFPA 54:12.4.3.4]

510.3.4.6 The exit terminals of mechanical draft systems shall be not less than 7 feet (2.1 m) above grade where located adjacent to public walkways and shall be located as specified in Sections 510.8.1 and 510.8.2 of this code. [NFPA 54:12.4.3.6]

510.3.5 Ventilating Hoods and Exhaust Systems.

510.3.5.1 Ventilating hoods and exhaust systems shall be permitted to be used to vent gas utilization equipment installed in commercial applications. [NFPA 54:12.4.4.1]

510.3.5.2 Where automatically operated gas utilization equipment is vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, provisions shall be made to allow the flow of gas to the main burners only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation. [NFPA 54:12.4.4.2]

510.3.6 Circulating Air Ducts and Furnace Plenums.

No portion of a venting system shall

extend into or pass through any circulating air duct or furnace plenum. [NFPA 54:12.4.5.1]

510.4 Type of Venting System to Be Used.

510.4.1 The type of venting system to be used shall be in accordance with Table 5-2. [NFPA 54:12.5.1]

510.4.2 Plastic Piping. Plastic piping used for venting equipment listed for use with such venting materials shall be approved. [NFPA 54:12.5.2]

510.4.3 Special Gas Vent. Special gas vent shall be listed and installed in accordance with the terms of the special gas vent listing and the manufacturer's instructions. [NFPA 54:12.5.3]

510.5 Masonry, Metal, and Factory-Built Chimneys.

510.5.1 Listing or Construction.

510.5.1.1 Factory-built chimneys shall be installed in accordance with their listing and the manufacturers' instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application. [NFPA 54:12.6.1.1]

510.5.1.2 Metal chimneys shall be built and installed in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*. [NFPA 54:12.6.1.2]

510.5.1.3 Masonry chimneys shall be built and installed in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, and lined with approved clay flue lining, a listed chimney lining system, or other approved material that will resist corrosion, erosion, softening, or cracking from vent gases at temperatures up to 1800°F (982°C). [NFPA 54:12.6.1.3]

Exception: Masonry chimney flues lined with a chimney lining system specifically listed for use with listed gas appliances with draft hoods, Category I appliances, and other gas appliances listed for use with Type B vents shall be permitted. The liner shall be installed in accordance with the liner manufacturer's instructions and the terms of the listing. A permanent identifying label shall be attached at the point where the connection is to be made to the liner. The label shall read: "This chimney liner is for appliances that burn gas only. Do not connect to solid- or liquid-fuel-burning appliances or incinerators." [NFPA 54:12.6.1.3]

510.5.2 Termination.

510.5.2.1 A chimney for residential-type or low-heat gas utilization equipment shall

extend at least 3 feet (0.9 m) above the highest point where it passes through a roof of a building and at least 2 feet (0.6 m) higher than any portion of a building within a horizontal distance of 10 feet (3.0 m). [See Figure 5-1.] [NFPA 54:12.6.2.1]

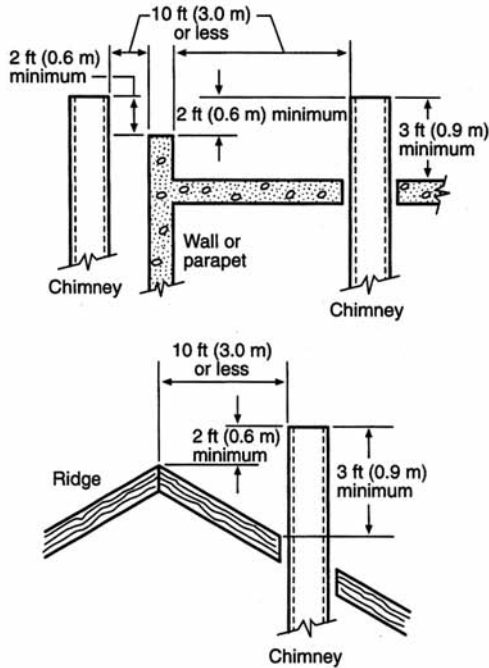
510.5.2.2 A chimney for medium-heat equipment shall extend at least 10 feet (3.0 m) higher than any portion of any building within 25 feet (7.6 m). [NFPA 54:12.6.2.2]

510.5.2.3 A chimney shall extend at least 5 feet (1.5 m) above the highest connected equipment draft hood outlet or flue collar. [NFPA 54:12.6.2.3]

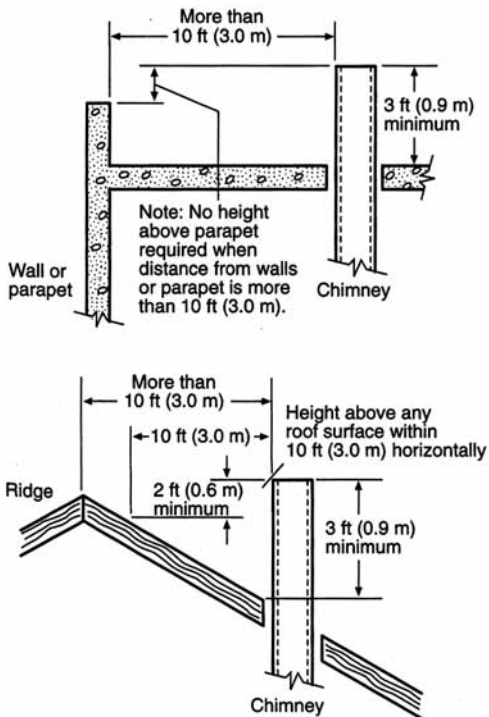
510.5.2.4 Decorative shrouds shall not be installed at the termination of factory-built chimneys except where such shrouds are listed and labeled for use with the specific factory-built chimney system and are installed in accordance with manufacturers' installation instructions. [NFPA 54:12.6.2.4]

510.5.3 Size of Chimneys. The effective area of a chimney venting system serving listed gas appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods [NFPA 54:12.6.3.1(1)]:

- (1) This chapter and NFPA 54: Chapter 13. [NFPA 54:12.6.3.1(1)]
- (2) For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue shall be not less than the area of the appliance flue collar or draft hood outlet or greater than seven times the draft hood outlet area. [NFPA 54:12.6.3.1(2)]
- (3) For sizing a chimney venting system connected to two appliances with draft hoods, the effective area of the chimney flue shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet, or greater than seven times the smallest draft hood outlet area. [NFPA 54:12.6.3.1(3)]
- (4) Other approved engineering methods. [NFPA 54:12.6.3.1(5)]
- (5) Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.6.3.1(4)] Where an incinerator is vented by a chimney serving other gas utilization equipment, the gas input to the incinerator shall not be included in calculating chimney size, provided the chimney flue diameter is not less than 1



(a) Termination 10 ft (3.0 m) or Less from Ridge, Wall, or Parapet



(b) Termination More Than 10 ft (3.0 m) from Ridge, Wall, or Parapet

FIGURE 5-1 Typical Termination Locations for Chimneys and Single-Wall Metal Pipes Serving Residential-Type and Low-Heat Equipment [NFPA 54:Figure 12.6.2.1]

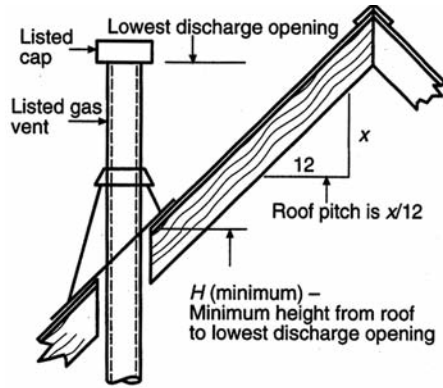
inch (25 mm) larger in equivalent diameter than the diameter of the incinerator flue outlet. [NFPA 54:12.6.3.2]

510.5.4 Inspection of Chimneys.

- (A) Before replacing an existing appliance or connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is clear and free of obstructions and shall be cleaned if previously used for venting solid- or liquid-fuel-burning appliances or fireplaces. [NFPA 54:12.6.4.1]
- (B) Chimneys shall be lined in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances*. [NFPA 54:12.6.4.2]
- (C) Cleanouts shall be examined to determine that they will remain tightly closed when not in use. [NFPA 54:12.6.4.3]
- (D) When inspection reveals that an existing chimney is not safe for the intended application, it shall be repaired, rebuilt, lined, relined, or replaced with a vent or chimney to conform to NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel-Burning Appliances*, and shall be suitable for the equipment to be attached. [NFPA 54:12.6.4.4]

510.5.5 Chimney Serving Equipment Burning Other Fuels.

- 510.5.5.1** Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel. [NFPA 54:12.6.5.1]
- 510.5.5.2** Where one chimney serves gas utilization equipment and equipment burning liquid fuel, the equipment shall be connected through separate openings or shall be connected through a single opening where joined by a suitable fitting located as close as practical to the chimney. Where two or more openings are provided into one chimney flue, they shall be at different levels. Where the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device. [NFPA 54:12.6.5.2]
- 510.5.5.3** A listed combination gas- and solid-fuel-burning appliance connected to a single chimney flue shall be equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage. The chimney flue shall be sized to properly vent the appliance. [NFPA 54: 12.6.5.3]



Roof pitch heights

Roof pitch	H(minimum) ft.	m
Flat to 6/12	1.0	0.30
Over 6/12 to 7/12	1.25	0.38
Over 7/12 to 8/12	1.5	0.46
Over 8/12 to 9/12	2.0	0.61
Over 9/12 to 10/12	2.5	0.76
Over 10/12 to 11/12	3.25	0.99
Over 11/12 to 12/12	4.0	1.22
Over 12/12 to 14/12	5.0	1.52
Over 14/12 to 16/12	6.0	1.83
Over 16/12 to 18/12	7.0	2.13
Over 18/12 to 20/12	7.5	2.27
Over 20/12 to 21/12	8.0	2.44

FIGURE 5-2 Gas Vent Termination Locations for Listed Caps 12 in. (300 mm) or Less in Size at Least 8 ft. (2.4 m) from a Vertical Wall [NFPA 54: Figure 12.7.2 and Table 12.7.2]

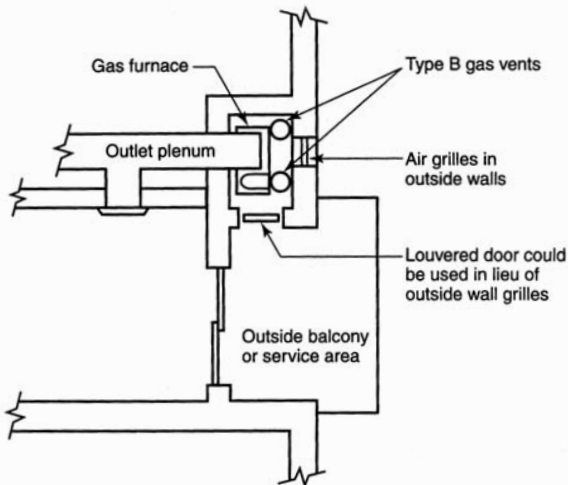


FIGURE 5-3 Plan View of Practical Separation Method for Multistory Gas Venting. [NFPA 54: Figure 12.7.4.2]

**TABLE 5-2
Type of Venting System to Be Used**

Gas Utilization Equipment	Type of Venting System
Listed Category I equipment	Type B gas vent (510.6)
Listed equipment equipped with draft hood	Chimney (510.5)
Equipment listed for use with Type B gas vent system for gas venting	Single-wall metal pipe (510.7)
	Listed chimney lining (510.5.1.3)
	Special gas vent listed for this equipment (510.4.3)
Listed vented wall furnaces	Type B-W gas vent (510.6, 510.6.2.2)
Category II equipment	As specified or furnished
Category III equipment	By manufacturers of listed
Category IV equipment	equipment (510.4.2, 510.4.3)
Incinerators, outdoors	Single-wall metal pipe (510.7, 510.7.3)
Incinerators, indoors	Chimney (510.5)
Equipment that can be converted to use of solid fuel	
Unlisted combination gas- and oil-burning equipment	
Combination gas- and solid-fuel-burning equipment	
Equipment listed for use with chimneys only	
Unlisted equipment	
Listed combination gas- and oil-burning equipment	Type L vent (510.6) or chimney (510.5)
Decorative appliance in vented fireplace	Chimney [UMC 907.2(3)]
Gas-fired toilets	Single-wall metal pipe (510.7, NFPA 54: 9.25.3)
Direct-vent equipment	See 510.2.5
Equipment with integral vent	See 510.2.6

[NFPA 54: Table 12.5.1]

510.5.5.4 A single chimney flue serving a listed combination gas- and oil-burning appliance shall be sized to properly vent the appliance. [NFPA 54: 12.6.5.4]

510.5.6 Support of Chimneys. All portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturers' instructions. [NFPA 54: 12.6.6]

510.5.7 Cleanouts. Where a chimney that formerly carried flue products from liquid- or solid-fuel-burning appliances is used with an appliance using fuel gas, an accessible cleanout shall be provided. The cleanout shall have a tight-fitting cover and be installed so its upper edge is at least 6 inches (150 mm) below the lower edge of the lowest chimney inlet opening. [NFPA 54: 12.6.7]

510.5.8 Space Surrounding Lining or Vent.

510.5.8.1 The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue shall not be used to vent another appliance. [NFPA 54: 12.6.8.1]

Exception: The insertion of another liner or vent within the chimney as provided in this code and the liner or vent manufacturer's instructions.

510.5.8.2 The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue shall not be used to supply combustion air. [NFPA 54: 12.6.8.2]

Exception: Direct-vent gas-fired appliances designed for installation in a solid-fuel-burning fireplace where installed in accordance with the listing and the manufacturer's instruction.

➔ **510.6 Gas Vents.**

510.6.1 A gas vent passing through a roof shall extend through the entire roof flashing, roof jack, or roof thimble and be terminated with a listed termination cap. [NFPA 54-2002: 10.6.1(3)]

510.6.1.1 Type B or Type L vents shall extend in a generally vertical direction with offsets not exceeding 45 degrees, except that a vent system having not more than one 60-degree offset shall be permitted. Any angle greater than 45 degrees from the vertical is considered horizontal. The total horizontal distance of a vent plus the horizontal vent connector serving draft-hood-equipped appliances shall not be greater than 75 percent of the vertical height of the vent. [NFPA 54-2002: 10.6.1(4)]

Exception: Systems designed and sized as provided in this chapter or in accordance with other approved engineering methods.

510.6.1.2 Vents serving Category I fan-assisted appliances shall be installed in accordance with the appliance manufacturer's instructions and NFPA 54, Chapter 10 or other approved engineering methods. [NFPA 54: 12.7.1(3)]

510.6.2 A gas vent shall terminate in accordance with one of the following [NFPA 54: 12.7.2(1)]:

- (1) Above the roof surface with a listed cap or listed roof assembly. Gas vents 12 inches (300 mm) in size or smaller with listed caps shall be permitted to be terminated in accordance with Figure 5-2, provided they are at least 8 feet (2.4 m) from a vertical wall or similar obstruction. All other gas vents shall terminate not less than 2 feet (0.6 m) above the highest point where they pass through the roof and at least 2 feet (0.6 m) higher than any portion of a building within 10 feet (3.1 m).
- (2) Industrial gas utilization equipment as provided in Section 510.2.4. [NFPA 54: 12.7.2(1)(c)]
- (3) Direct-vent systems as provided in Section 510.2.5. [NFPA 54: 12.7.2(1)(d)]
- (4) Equipment with integral vents as provided in Section 510.2.6. [NFPA 54: 12.7.2(1)(e)]
- (5) Mechanical draft systems as provided in Section 510.3.4. [NFPA 54: 12.7.2(1)(f)]
- (6) Ventilating hoods and exhaust systems as provided in Section 510.3.5. [NFPA 54: 12.7.2(1)(g)]

510.6.2.1 A Type B or a Type L gas vent shall terminate at least 5 feet (1.5 m) in vertical height above the highest connected equipment draft hood or flue collar. [NFPA 54: 12.7.2(2)]

510.6.2.2 A Type B-W gas vent shall terminate at least 12 feet (3.7 m) in vertical height above the bottom of the wall furnace. [NFPA 54: 12.7.2(3)]

510.6.2.3 A gas vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in Sections 510.2.5 and 510.3.4. [NFPA 54: 12.7.2(4)]

510.6.2.4 Decorative shrouds shall not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with manufacturers' installation instructions. [NFPA 54: 12.7.2(5)]

510.6.2.5 All gas vents shall extend through the roof flashing, roof jack, or roof thimble and terminate with a listed cap or listed roof assembly. [NFPA 54: 12.7.2(6)]

510.6.2.6 A gas vent shall terminate at least 3 feet (0.9m) above a forced air inlet located within 10 feet (3.0m). [NFPA 54: 12.7.2(7)]

510.6.3 Size of Gas Vents. Venting systems

shall be sized and constructed in accordance with NFPA 54, Chapter 3 or other approved engineering methods and the gas vent and gas equipment manufacturers' instructions. [NFPA 54: 12.7.3]

510.6.3.1 Category I Appliances. The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with Type B gas vent, installed in a single story of a building, shall be in accordance with one of the following methods. [NFPA 54: 12.7.3.1]

- (1) The provisions of this chapter. [NFPA 54: 12.7.3.1(1)]
- (2) Vents serving fan-assisted combustion system appliances, or combinations of fan-assisted combustion systems and draft hood-equipped appliances, shall be sized in accordance with this chapter or other approved engineering methods. [NFPA 54: 12.7.3.1(2)]

- (3) 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 or greater than seven times the draft hood outlet area. [NFPA 54: 12.7.3.1(3)]
- (4) For sizing a gas vent connected to two appliances with draft hoods, the effective area of the vent shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet or greater than seven times the smaller draft hood outlet area. [NFPA 54: 12.7.3.1(4)]
- (5) Approved engineering practices. [NFPA 54: 12.7.3.1(5)]

510.6.3.2 Category II, Category III, and Category IV Appliances. The sizing of gas vents for Category II, Category III, and Category IV gas utilization equipment shall be in accordance with the equipment

TABLE 5-3
Clearance for Connectors [NFPA 54: Table 12.8.4.4]

Equipment	Minimum Distance from Combustible Material			
	Listed Type B Gas Vent Material	Listed Type L Vent Material	Single-Wall Metal Pipe	Factory-Built Chimney Sections
Listed equipment with draft hoods and equipment listed for use with Type B gas vents	As listed	As listed	6 in.	As listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 in.	6 in.	9 in.	As listed
Residential appliances listed for use with Type L vents	Not permitted	As listed	9 in.	As listed
Residential incinerators	Not permitted	9 in.	18 in.	As listed
Listed gas-fired toilets	Not permitted	As listed	As listed	As listed
Unlisted residential appliances with draft hood	Not permitted	6 in.	9 in.	As listed
Residential and low-heat equipment other than those above	Not permitted	9 in.	18 in.	As listed
Medium-heat equipment	Not permitted	Not permitted	36 in.	As listed

For SI units, 1 in. = 25.4 mm.

Note: These clearances shall apply unless the listing of an appliance or connector specifies clearances, in which case the listed clearances shall apply.

manufacturers' instructions. [NFPA 54:12.7.3.3]

510.6.3.3 Sizing. Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.7.3.4]

510.6.4 Gas Vents Serving Equipment on More Than One Floor.

510.6.4.1 A common gas vent shall be permitted in multistory installations to vent Category I gas utilization equipment located on more than one floor level, provided the venting system is designed and installed in accordance with approved engineering methods.

For the purpose of this section, crawl spaces, basements, and attics shall be considered as floor levels. [NFPA 54: 12.7.4.1]

510.6.4.2 All gas utilization equipment connected to the common vent shall be located in rooms separated from a habitable space. Each of these rooms shall have provisions for an adequate supply of combustion, ventilation, and dilution air that is not supplied from a habitable space. (See Figure 5-3.) [NFPA 54: 12.7.4.2]

The size of the connectors and common segments of multistory venting systems for gas utilization equipment listed for use with Type B double-wall gas vent shall be in accordance with Table 5-14, provided [NFPA 54: 12.7.4.3]:

- (1) The available total height (H) for each segment of a multistory venting system is the vertical distance between the level of the highest draft hood outlet or flue collar on that floor and the centerline of the next highest interconnection tee. (See Figure G.1(K).) [NFPA 54: 12.7.4.2(1)]
- (2) The size of the connector for a segment is determined from its gas utilization equipment heat input and available connector rise, and shall not be smaller than the draft hood outlet or flue collar size. [NFPA 54: 12.7.4.2(2)]
- (3) The size of the common vertical vent segment, and of the interconnection tee at the base of that segment, shall be based on the total gas utilization equipment heat input entering that segment and its available total height. [NFPA 54: 12.7.4.2(3)]

510.6.5 Support of Gas Vents. Gas vents shall be supported and spaced in accordance with their listings and the manufacturers' instructions. [NFPA 54: 12.7.5]

510.6.6 Marking. In those localities where solid

and liquid fuels are used extensively, gas vents shall be permanently identified by a label attached to the wall or ceiling at a point where the vent connector enters the gas vent. The label shall read: "This gas vent is for appliances that burn gas. Do not connect to solid- or liquid-fuel-burning appliances or incinerators." The Authority Having Jurisdiction shall determine whether its area constitutes such a locality. [NFPA 54:12.7.6]

510.7 Single-Wall Metal Pipe.

510.7.1 Construction. Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304 inch (0.7 mm) thick or of other approved, noncombustible, corrosion-resistant material. [NFPA 54: 12.8.1]

510.7.2 Cold Climate. Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment in regions where the 99 percent winter design temperature is below 32° Fahrenheit. [NFPA 54:12.8.2]

510.7.3 Termination. The termination of single-wall metal pipe shall comply with the following requirements [NFPA 54: 12.8.3]:

510.7.3.1 Single-wall metal pipe shall terminate at least 5 feet (1.5 m) in vertical height above the highest connected equipment draft hood outlet or flue collar. [NFPA 54: 12.8.3(1)]

510.7.3.2 Single-wall metal pipe shall extend at least 2 feet (0.6 m) above the highest point where it passes through the roof of a building and at least 2 feet (0.6 m) higher than any portion of a building within a horizontal distance of 10 feet (3.1 m). [See Figure 5-1.] [NFPA 54: 12.8.3(2)]

510.7.3.3 An approved cap or roof assembly shall be attached to the terminus of a single-wall metal pipe. [Also see Section 510.7.4.2.] [NFPA 54: 12.8.3(3)]

510.7.4 Installation with Equipment Permitted by 510.4.1.

510.7.4.1 Single-wall metal pipe shall be used only for runs directly from the space in which the gas utilization equipment is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket, or roof thimble. [NFPA 54: 12.8.4.1]

510.7.4.2 Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space, or floor. For the installation of a single-wall

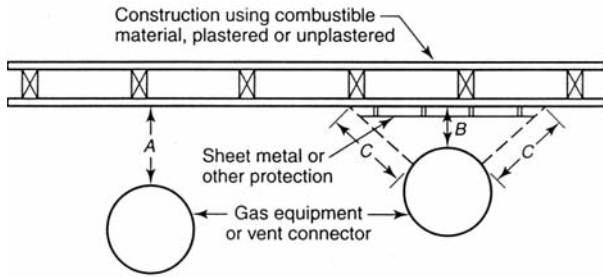
**Table 5-4
Reduction of Clearances with Specified Forms of Protection [NFPA 54:Table 10.2.3(b)]**

Type of protection applied to and covering all surfaces of combustible material within the distance specified as the required clearance with no protection [See Figures 5-4 through 5-6.]	Where the required clearance with no protection from appliance, vent connector, or single-wall metal pipe is:									
	36 in.		18 in.		12 in.		9 in.		6 in.	
	Allowable Clearances with Specified Protection (in.)									
	Use Col. 1 for clearances above appliance or horizontal connector. Use Col. 2 for clearances from appliances, vertical connector, and single-wall metal pipe.									
	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2
(1) 3-1/2 in. thick masonry wall without ventilated air space	--	24	--	12	--	9	--	6	--	5
(2) 1/2 in. insulation board over 1 in. glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
(3) 0.024 sheet metal over 1 in. glass fiber or mineral wool batts reinforced with wire on rear face with ventilated air space	18	12	9	6	6	4	5	3	3	3
(4) 3-1/2 in. thick masonry wall with ventilated air space	--	12	--	6	--	6	--	6	--	6
(5) 0.024 sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	2
(6) 1/2 in. thick insulation board with ventilated air space	18	12	9	6	6	4	5	3	3	3
(7) 0.024 sheet metal with ventilated air space over 0.024 sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	3
(8) 1 in. glass fiber or mineral wool batts sandwiched between two sheets 0.024 sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	3

For SI units, 1 in. = 25.4 mm.

Notes:

- Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
- All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
- Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite the appliance or connector.
- Where all clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. [See Figure 5-5 and Figure 5-6.]
- There shall be at least 1 in. (25 mm) between clearance reduction systems and combustible walls and ceilings for reduction systems using a ventilated air space.
- Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1 inch (25 mm) air gap. To provide adequate air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
- Mineral wool batts (blanket or board) shall have a minimum density of 8 lb/ft³ (128 kg/m³) and a minimum melting point of 1,500°F (816°C).
- Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu in./ft²/h-°F (0.144 W/m-K) or less.
- There shall be at least 1 inch (25 mm) between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in this table.
- All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
- Listed single-wall connectors shall be installed in accordance with the terms of their listing and the manufacturers' instructions.

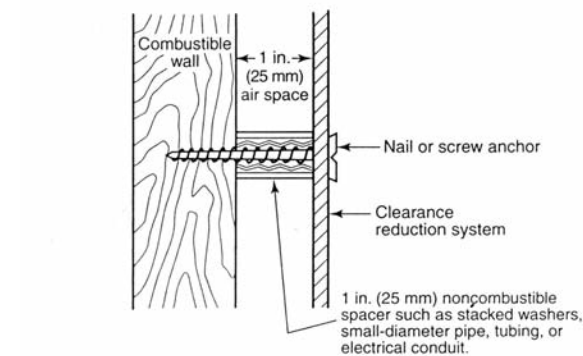
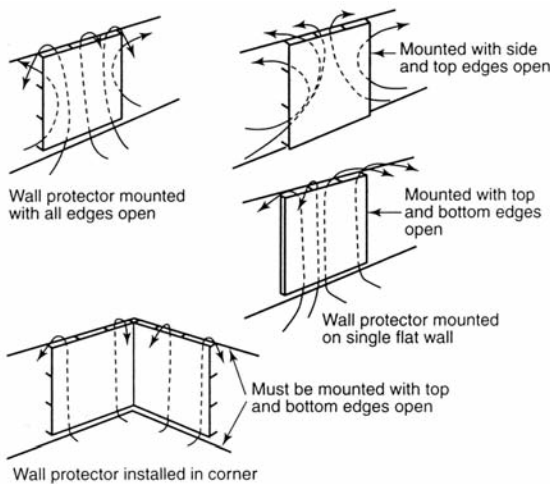


Notes:

A – Equals the clearance with no protection specified in Tables 5-3 and 5-4 and in the sections applying to various types of equipment.

B – Equals the reduced clearance permitted in accordance with Table 5-3. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

FIGURE 5-4 Extent of Protection Necessary to Reduce Clearances from Gas Equipment or Vent Connectors. [NFPA 54:Figure 10.3.2.2(a)]



Masonry walls can be attached to combustible walls using wall ties. Spacers should not be used directly behind appliance or connector.

FIGURE 5-5 Wall Protection Reduction System. [NFPA 54:Figure 10.3.2.2(b)]

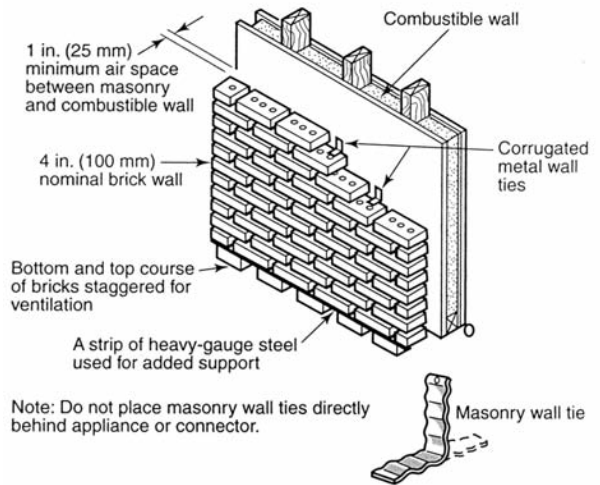


FIGURE 5-6 Masonry Clearance Reduction System. [NFPA 54:Figure 10.3.2.2(c)]

**TABLE 5-5
Minimum Thickness for Galvanized Steel Vent Connector for Low-Heat Appliances
[NFPA 54:Table 12.11.2.5]**

Diameter of Connector (in.)	Minimum Thickness (in.)*
Less than 6	0.019
6 to less than 10	0.023
10 to 12 inclusive	0.029
14 to 16 inclusive	0.034
Over 16	0.056

* For SI units, 1 in. = 25.4 mm; 1 in.² = 645 mm².

metal pipe through an exterior combustible wall, see Section 510.10.14.2. [NFPA 54:12.8.4.2]

510.7.4.3 Single-wall metal pipe used for venting an incinerator shall be exposed and readily examinable for its full length and shall have suitable clearances maintained. [NFPA 54:12.8.4.3]

510.7.4.4 Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table 5-3. Reduced clearances from single-wall metal pipe to combustible material shall be as specified for vent connectors in Table 5-4. [NFPA 54:12.8.4.4]

510.7.4.5 Where a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend at

least 18 inches (460 mm) above and 6 inches (150 mm) below the roof with the annular space open at the bottom and closed only at the top. The thimble shall be sized in accordance with Section 510.10.14.2. [NFPA 54: 12.8.4.5]

510.7.5 Size of Single-Wall Metal Pipe. Single-wall metal piping shall comply with the following requirements [NFPA 54: 12.8.5]:

510.7.5.1 A venting system of a single-wall metal pipe shall be sized in accordance with one of the following methods and the gas equipment manufacturer's instructions [NFPA 54: 12.8.5(1)]:

- (1) For a draft-hood-equipped appliance, in accordance with this chapter. [NFPA 54: 12.8.5(1,a)]
- (2) For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall not be less than the area of the appliance flue collar or draft hood outlet, whichever is smaller. The vent area shall not be greater than seven times the draft hood outlet area. [NFPA 54: 12.8.5(1,b)]
- (3) Other approved engineering methods. [NFPA 54: 12.8.5(1,c)]

510.7.5.2 Where a single-wall metal pipe is used and has a shape other than round, it shall have an equivalent effective area equal to the effective area of the round pipe for which it is substituted, and the minimum internal dimension of the pipe shall be 2 inches (50 mm). [NFPA 54: 12.8.5(2)]

510.7.5.3 The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached. [NFPA 54: 12.8.5(3)]

510.7.6 Support of Single-Wall Metal Pipe. All portions of single-wall metal pipe shall be supported for the design and weight of the material employed. [NFPA 54: 12.8.6]

510.7.7 Marking. Single-wall metal pipe shall comply with the marking provisions of Section 510.6.6. [NFPA 54:12.8.7]

510.8 Through-the-Wall Vent Termination. (See Figure 5-12.)

510.8.1 A mechanical draft venting system shall terminate at least 3 feet (0.9 m) above any forced air inlet located within 10 feet (3.1 m). [NFPA 54: 12.9.1]

Exception No. 1: This provision shall not apply to the combustion air intake of a direct-vent appliance.

Exception No. 2: This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances.

510.8.2 A mechanical draft venting system of other than direct-vent type shall terminate at least 4 feet (1.2 m) below, 4 feet (1.2 m) horizontally from, or 1 foot (300 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 inches (300 mm) above grade. [NFPA 54: 12.9.2]

510.8.3 The vent terminal of a direct-vent appliance with an input of 10,000 Btu/h (3 kW) or less shall be located at least 6 inches (150 mm) from any air opening into a building, and such an appliance with an input over 10,000 Btu/h (3 kW) but not over 50,000 Btu/h (14.7 kW) shall be installed with a 9-inch (230 mm) vent termination clearance, and an appliance with an input over 50,000 Btu/h (14.7 kW) shall have at least a 12 inch (300-mm) vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least 12 inches (300 mm) above grade. [NFPA 54: 12.9.3]

510.8.4 Through-the-wall vents for Category II and Category IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and Category III appliances, this provision shall also apply. [NFPA 54:12.9.4]

510.9 Condensation Drain.

510.9.1 Provision shall be made to collect and dispose of condensate from venting systems serving Category II and Category IV gas utilization equipment and noncategorized condensing appliances in accordance with Section 510.8.4. [NFPA 54: 12.10.1]

510.9.2 Where local experience indicates that condensation is a problem, provision shall be made to drain off and dispose of condensate from venting systems serving Category I and Category III gas utilization equipment in accordance with 510.8.4. [NFPA 54:10.9.2]

510.10 Vent Connectors for Category I Gas Utilization Equipment.

510.10.1 Where Required. A vent connector shall be used to connect gas utilization equipment to a gas vent, chimney, or single-wall metal pipe, except where the gas vent, chimney, or single-wall metal pipe is directly connected to the equipment. [NFPA 54: 12.11.1]

510.10.2 Materials.

510.10.2.1 A vent connector shall be made of noncombustible, corrosion resistant material capable of withstanding the vent gas temperature produced by the gas utilization equipment and of sufficient thickness to withstand physical damage. [NFPA 54: 12.11.2.1]

510.10.2.2 Where the vent connector used for gas utilization equipment having a draft hood or a Category I appliance is located in or passes through an unconditioned area, that portion of the vent connector shall be listed Type B, Type L, or listed vent material having equivalent insulation qualities. [NFPA 54: 12.11.2.2]

Exception: Single-wall metal pipe located within the exterior walls of the building and located in areas having a local 99 percent winter design temperature of 5°F or higher.

510.10.2.3 Where the vent connector used for gas utilization equipment having a draft hood or a Category I appliance is located in or passes through attics and crawl spaces, that portion of the vent connector shall be listed Type B, Type L, or listed vent material having equivalent insulation qualities. [NFPA 54: 12.11.2.3]

510.10.2.4 Vent connectors for residential-type appliances shall comply with the following: [NFPA 54: 12.11.2.4]

- (1) Vent Connectors Not Installed in Attics, Crawl Spaces, or Other Unconditioned Areas. Vent connectors for listed gas appliances having draft hoods and for appliances having draft hoods and equipped with listed conversion burners that are not installed in attics, crawl spaces, or other unconditioned areas shall be one of the following:
 - (a) Type B or Type L vent material.
 - (b) Galvanized sheet steel not less than 0.018-inches (0.46 mm) thick.
 - (c) Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027-inches (0.69 mm) thick.

- (d) Stainless steel sheet not less than 0.012-inches (0.31 mm) thick.
 - (e) Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of b, c, or d above.
 - (f) A listed vent connector.
- (2) Vent connectors shall not be covered with insulation.

Exception: Listed insulated vent connectors shall be installed according to the terms of their listing.

510.10.2.5 A vent connector for non-residential low-heat equipment shall be a factory-built chimney section or steel pipe having resistance to heat and corrosion equivalent to that for the appropriate galvanized pipe as specified in Table 5-5. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturer's instructions. [NFPA 54: 12.11.2.5]

510.10.2.6 Vent connectors for medium-heat equipment and commercial and industrial incinerators shall be constructed of factory-built, medium-heat chimney sections or steel of a thickness not less than that specified in Table 5-6 and shall comply with the following: [NFPA 54: 12.11.2.6]

- (1) A steel vent connector for equipment with a vent gas temperature in excess of 1,000°F (538°C) measured at the entrance to the connector shall be lined with medium-duty fire brick (ASTM C 64, Specification for Refractories for Incinerators and Boilers, Type F) or the equivalent.
- (2) The lining shall be at least 2-1/2 inches (64 mm) thick for a vent connector having a diameter or greatest cross sectional dimension of 18 inches (460 mm) or less.
- (3) The lining shall be at least 4-1/2 inches (110 mm) thick laid on the 4-1/2 inch (110-mm) bed for a vent connector having a diameter or greatest cross-sectional dimension greater than 18 inches (460 mm).
- (4) Factory-built chimney sections, if employed, shall be joined together in accordance with the chimney manufacturer's instructions.

TABLE 5-6
Minimum Thickness for Steel Vent Connectors
for Medium-Heat Equipment and Commercial and
Industrial Incinerators
[NFPA 54: Table 12.11.2.6]

Vent Connector Size		Minimum
Diameter (in.)	Area (in. ²)	Thickness (in.)
Up to 14	Up to 154	0.053
Over 14 to 16	154 to 201	0.067
Over 16 to 18	201 to 254	0.093
Over 18	Larger than 254	0.123

For SI units, 1 in. = 25.4 mm; 1 in.² = 645 mm².

510.10.3 Size of Vent Connector.

510.10.3.1 A vent connector for gas utilization equipment with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with this chapter or other approved engineering methods. [NFPA 54: 12.11.3.1]

510.10.3.2 For a single appliance having more than one draft hood outlet or flue collar, the manifold shall be constructed according to the instructions of the appliance manufacturer. Where there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As an alternate method, the effective area of the manifold shall equal the combined area of the flue collars or draft hood outlets, and the vent connectors shall have a minimum 1-foot (0.3 m) rise. [NFPA 54: 12.11.3.2]

510.10.3.3 Where two or more gas appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with this chapter or other approved engineering methods. [NFPA 54: 12.11.3.3] As an alternative method applicable only when all of the appliances are draft-hood-equipped, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected. [NFPA 54: 12.11.3.4]

510.10.3.4 Where two or more gas appliances are vented through a common vent connector or vent manifold, the common vent connector or vent manifold shall be located at the highest level consistent with available head-

room and clearance to combustible material and shall be sized in accordance with this chapter or other approved engineering methods. [NFPA 54: 12.11.3.5]

As an alternate method applicable only where there are two draft-hood-equipped appliances, the effective area of the common vent connector or vent manifold and all junction fittings shall be not less than the area of the larger vent connector plus 50 percent of the areas of smaller flue collar outlets. [NFPA 54: 12.11.3.6]

510.10.3.5 Where the size of a vent connector is increased to overcome installation limitations and obtain connector capacity equal to the equipment input, the size increase shall be made at the equipment draft hood outlet. [NFPA 54: 12.11.3.7]

510.10.4 Two or More Appliances Connected to a Single Vent.

510.10.4.1 Where two or more vent connectors enter a common gas vent, chimney flue, or single-wall metal pipe, the smaller connector shall enter at the highest level consistent with the available headroom or clearance to combustible material. [NFPA 54: 12.11.4.1]

510.10.4.2 Vent connectors serving Category I appliances shall not be connected to any portion of a mechanical draft system operating under positive static pressure, such as those serving Category III or Category IV appliances. [NFPA 54: 12.11.4.2]

510.10.5 Clearance. Minimum clearances from vent connectors to combustible material shall be in accordance with Table 5-3. [NFPA 54: 12.11.5]

Exception: The clearance between a vent connector and combustible material shall be permitted to be reduced where the combustible material is protected as specified for vent connectors in Table 5-4.

510.10.6 Avoid Unnecessary Bends. A vent connector shall be installed so as to avoid turns or other construction features that create excessive resistance to flow of vent gases. [NFPA 54: 12.11.6]

510.10.7 Joints. Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods: [NFPA 54: 12.11.7]

- (1) By sheet metal screws.

- (2) Vent connectors of listed vent material shall be assembled and connected to flue collars or draft hood outlets in accordance with the manufacturers' instructions.
- (3) Other approved means.

510.10.8 Slope. A vent connector shall be installed without any dips or sags and shall slope upward toward the vent or chimney at least 1/4 in./ft. (20 mm/m). [NFPA 54: 12.11.8]

Exception: Vent connectors attached to a mechanical draft system installed in accordance with the manufacturers' instructions.

510.10.9 Length of Vent Connector.

510.10.9.1 A vent connector shall be as short as practical and the gas utilization equipment located as close as practical to the chimney or vent. [NFPA 54: 12.11.9.1]

510.10.9.2 The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent except for engineered systems. The maximum length of an individual connector for a chimney or vent system serving multiple appliances, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent. [NFPA 54: 12.11.9.2]

510.10.9.3 The maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent, except for engineered systems. The maximum length of an individual connector for a chimney or vent system serving multiple appliances, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent. [NFPA 54:12.11.9.3]

510.10.10 Support. A vent connector shall be supported for the design and weight of the material employed to maintain clearances and prevent physical damage and separation of joints. [NFPA 54: 12.11.10]

510.10.11 Chimney Connection. Where entering a flue in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. Where a thimble or slip joint is used to facilitate removal of the connector, the connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out.

Means shall be employed to prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney flue. [NFPA 54: 12.11.11]

510.10.12 Inspection. The entire length of a vent connector shall be readily accessible for inspection, cleaning, and replacement. [NFPA 54: 12.11.12]

510.10.13 Fireplaces. A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed. [NFPA 54: 12.11.13]

510.10.14 Passage through Ceilings, Floors, or Walls.

510.10.14.1 A vent connector shall not pass through any ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through any interior wall.

Exception: Vent connectors made of listed Type B or Type L vent material and serving listed equipment with draft hoods and other equipment listed for use with Type B gas vents that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material.

510.10.14.2 A vent connector made of a single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following: [NFPA 54: 12.11.14.2]

- (1) For listed appliances equipped with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be a minimum of 4 inches (100 mm) larger in diameter than the vent connector. Where there is a run of not less than 6 feet (1.8 m) of vent connector in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum of 2 inches (50 mm) larger in diameter than the vent connector.
- (2) For unlisted appliances having draft hoods, the thimble shall be a minimum of 6 inches (150 mm) larger in diameter than the vent connector.
- (3) For residential and low-heat appliances, the thimble shall be a minimum of 12

inches (300 mm) larger in diameter than the vent connector.

Exception: In lieu of thimble protection, all combustible material in the wall shall be removed from the vent connector a sufficient distance to provide the specified clearance from such vent connector to combustible material. Any material used to close up such opening shall be noncombustible.

510.10.14.3 Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material. [NFPA 54: 12.11.14.3]

510.11 Vent Connectors for Category II, Category III, and Category IV Gas Utilization Equipment. (See Section 510.4.) [NFPA 54:12.12]

510.12 Draft Hoods and Draft Controls.

510.12.1 Equipment Requiring Draft Hoods. Vented gas utilization equipment shall be installed with draft hoods. [NFPA 54: 12.13.1]

Exception: Dual oven-type combination ranges; incinerators; direct-vent equipment; fan-assisted combustion system appliances; equipment requiring chimney draft for operation; single firebox boilers equipped with conversion burners with inputs greater than 400,000 Btu/h (117 kW); equipment equipped with blast, power, or pressure burners that are not listed for use with draft hoods; and equipment designed for forced venting.

510.12.2 Installation. A draft hood supplied with or forming a part of listed vented gas utilization equipment shall be installed without alteration, exactly as furnished and specified by the equipment manufacturer. [NFPA 54: 12.13.2] If a draft hood is not supplied by the equipment manufacturer where one is required, a draft hood shall be installed, be of a listed or approved type, and, in the absence of other instructions, be of the same size as the equipment flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type. [NFPA 54: 12.13.2.1] Where it is determined that a draft hood of special design is needed or preferable for a particular installation, the

installation shall be in accordance with the recommendations of the equipment manufacturer and shall be with the approval of the Authority Having Jurisdiction. [NFPA 54: 12.13.2.2]

510.12.3 Draft-Control Devices. Where a draft-control device is part of the gas utilization equipment or is supplied by the equipment manufacturer, it shall be installed in accordance with the manufacturer's instructions. In the absence of manufacturer's instructions, the device shall be attached to the flue collar of the equipment or as near to the equipment as practical. [NFPA 54: 12.13.3]

510.12.4 Additional Devices. Gas utilization equipment (except incinerators) requiring controlled chimney draft shall be permitted to be equipped with a listed double-acting barometric draft regulator installed and adjusted in accordance with the manufacturers' instructions. [NFPA 54: 12.13.4]

510.12.5 Location. Draft hoods and barometric draft regulators shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54: 12.13.5]

510.12.6 Positioning. Draft hoods and draft regulators shall be installed in the position for which they were designed with reference to the horizontal and vertical planes and shall be located so that the relief opening is not obstructed by any part of the equipment or adjacent construction. The equipment and its draft hood shall be located so that the relief opening is accessible for checking vent operation. [NFPA 54; 12.13.6]

510.12.7 Clearance. A draft hood shall be located so that its relief opening is not less than 6 inches (150 mm) from any surface except that of the equipment it serves and the venting system to which the draft hood is connected. Where a greater or lesser clearance is indicated on the equipment label, the clearance shall not be less than that specified on the label. Such clearances shall not be reduced. [NFPA 54:12.13.7]

510.13 Manually Operated Dampers. A manually operated damper shall not be placed in any equipment vent connector. Fixed baffles

shall not be classified as manually operated dampers. [NFPA 54:12.14]

510.14 Automatically Operated Vent Dampers.

An automatically operated vent damper shall be of a listed type. [NFPA 54:12.15]

510.15 Obstructions. Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions: [NFPA 54:12.16]

- (1) Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the terms of their listing.
- (2) Approved draft regulators and safety controls designed and installed in accordance with approved engineering methods.
- (3) Listed heat reclaimers and automatically operated vent dampers installed in accordance with the terms of their listing.
- (4) Vent dampers serving listed appliances installed in accordance with this chapter or other approved engineering methods.
- (5) Approved economizers, heat reclaimers, and recuperators installed in venting systems of equipment not required to be equipped with draft hoods, provided the gas utilization equipment manufacturer's instructions cover the installation of such a device in the venting system and performance in accordance with Sections 510.3.1 and 510.3.2 is obtained.

511.0 Sizing of Category I Venting Systems.

511.1 These venting tables shall not be used where obstructions (see Section 510.15) are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturer's instructions or in accordance with the following: [NFPA 54: 13.1.1]

- (1) The maximum capacity of the vent system shall be determined using the NAT Max column.
- (2) The minimum capacity shall be determined as though the appliance were a fan-assisted appliance, using the FAN Min column to determine the minimum capacity of the vent system. Where the corresponding "FAN Min" is "NA" the vent configuration shall not be permitted and an alternative venting configuration shall be utilized.

511.1.1 Where the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the use of the smaller

size shall be permitted provided that the installation complies with all of the following requirements: [NFPA 54: 13.1.2]

- (1) The total vent height (H) is at least 10 feet (3 m).
- (2) Vents for appliance draft hood outlets or flue collars 12 inches (300 mm) in diameter or smaller are not reduced more than one table size.
- (3) Vents for appliance draft hood outlets or flue collars larger than 12 inches (300 mm) in diameter are not reduced more than two table sizes.
- (4) The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10 percent (0.90 maximum table capacity).
- (5) The draft hood outlet is greater than 4 inches (100 mm) in diameter. Do not connect a 3-inch (80mm) diameter vent to a 4-inch (100mm) diameter draft hood outlet. This provision shall not apply to fan-assisted appliances.

511.1.2 Single-appliance venting configurations with zero (0) lateral lengths in Tables 5-8, 5-9, and 5-12 shall have no elbows in the venting system. For vent configurations with lateral lengths, the venting tables include allowance for two 90-degree turns. For each additional elbow up to and including 45 degrees, the maximum capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees up to and including 90 degrees, the maximum capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54: 13.1.3]

511.1.3 Zero (0) lateral (L) shall apply only to a straight vertical vent attached to a top outlet draft hood or flue collar. [NFPA 54: 13.1.4]

511.1.4 Sea level input ratings shall be used when determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation.

[NFPA 54: 13.1.5]

511.1.5 For appliances with more than one input rate, the minimum vent capacity (FAN Min) determined from the tables shall be less than the lowest appliance input rating, and the maximum vent capacity (FAN Max/NAT Max) determined from the tables shall be greater than the highest appliance rating input. [NFPA 54: 13.1.6]

511.1.6 Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Tables 5-8 or 5-9 for Type B vents with the maximum capacity reduced by 20 percent (0.80 maximum capacity) and the minimum capacity as shown in Tables 5-8 or 5-9. Corrugated metallic liner systems installed with

bends or offsets shall have their maximum capacity further reduced in accordance with Section 511.1.2. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90-degree turn at the bottom of the liner. [NFPA 54: 13.1.7]

511.1.7 Where the vertical vent has a larger diameter than the vent connector, the vertical vent diameter shall be used to determine the minimum vent capacity, and the connector diameter shall be used to determine the maximum vent capacity. The flow area of the vertical vent shall not exceed seven times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54: 13.1.9]

511.1.8 Connection to Chimney Liners. Connections between chimney liners and listed double-wall connectors shall be made with listed adapters designed for such purposes. [NFPA 54: 13.1.8]

511.1.9 Vertical Vent Upsizing 7 x Rule. Where the vertical vent has a larger diameter than the vent connector, the vertical vent diameter shall be used to determine the minimum vent capacity, and the connector diameter shall be used to determine the maximum vent capacity. The flow area of the vertical vent shall not exceed seven times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54: 13.1.9]

511.1.10 Draft Hood Conversion Accessories. Draft hood conversion accessories for use with masonry chimneys venting listed Category I fan-assisted appliances shall be listed and installed in accordance with the listed accessory manufacturers' installation instructions. [NFPA 54:13.1.10]

511.1.11 Tables 5-8 through 5-12 shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. A Type B vent passing through an unventilated enclosure or chase insulated to a value of not less than R8 shall not be considered to be exposed to the outdoors. Table 5-10 in combination with Table 5-13 shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following are met: [NFPA 54: 13.1.11]

- (1) The vent connector is Type B double wall.
- (2) The vent connector length is limited to 1-1/2 feet for each inch (180 mm/mm) of vent

connector diameter.

- (3) The appliance is draft-hood-equipped.
- (4) The input rating is less than the maximum capacity given in Table 5-10.
- (5) For a water heater, the outdoor design temperature shall not be less than 5°F (15°C).
- (6) For a space-heating appliance, the input rating is greater than the minimum capacity given by Table 5-13.
- (7) Where the conditions of (1) through (6) cannot be met, an alternative venting design shall be used, such as a listed chimney lining system.

Exception: Vents serving listed appliances installed in accordance with the appliance instructions and the terms of the listing.

511.1.12 Corrugated vent connectors shall not be smaller than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54: 13.1.12]

511.1.13 Vent connectors shall not be upsized more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54: 13.1.13]

511.1.14 In a single run of vent or vent connector, more than one diameter and type shall be permitted to be used, provided that all the sizes and types are permitted by the tables. [NFPA 54: 13.1.14]

511.1.15 Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. (See Part II-Example G.1.3.) [NFPA 54: 13.1.15]

511.1.16 Extrapolation beyond the table entries shall not be permitted. [NFPA 54: 13.1.16]

511.1.17 For vent heights lower than 6 feet and higher than shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54: 13.1.17]

511.2 Additional Requirements to Multiple Appliance Vent Table 5-14 through Table 5-22.

511.2.1 Obstructions and Vent Damper. These venting tables shall not be used where obstructions (see Section 510.15) are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturers' instructions or in accordance with the following: [NFPA 54: 13.2.1]

- (1) The maximum capacity of the vent connector shall be determined using the NAT Max column.
- (2) The maximum capacity of the vertical vent

or chimney shall be determined using the FAN + NAT column when the second appliance is a fan-assisted appliance, or the NAT + NAT column when the second appliance is equipped with a draft hood.

- (3) The minimum capacity shall be determined as if the appliance were a fan-assisted appliance.
 - (a) The minimum capacity of the vent connector shall be determined using the FAN Min column.
 - (b) The FAN + FAN column shall be used when the second appliance is a fan-assisted appliance, and the FAN + NAT column shall be used when the second appliance is equipped with a draft hood, to determine whether the vertical vent or chimney configuration is not permitted (NA). Where the vent configuration is NA, the vent configuration shall not be permitted and an alternative venting configuration shall be utilized.

511.2.2 The maximum vent connector horizontal length shall be 18 in./in. (180 mm/mm) of connector diameter as shown in Table 5-7. [NFPA 54: 13.2.2]

511.2.3 The vent connector shall be routed to the vent utilizing the shortest possible route. Connectors with longer horizontal lengths than those listed in Table 5-7 are permitted under the following conditions: [NFPA 54: 13.2.3]

- (A) The maximum capacity (FAN Max or NAT Max) of the vent connector shall be reduced 10 percent for each additional multiple of the length listed in Table 5-7. For example, the maximum length listed for a 4-inches (100mm) connector is 6 feet (1.8 m). With a connector length greater than 6 feet (1.8 m) but not exceeding 12 feet (3.7 m), the maximum capacity must be reduced by 10 percent (0.90 maximum vent connector capacity). With a connector length greater than 12 feet (3.7 m) but not exceeding 18 feet (5.5 m), the maximum capacity must be reduced by 20 percent (0.80 maximum vent capacity).
- (B) For a connector serving a fan-assisted appliance, the minimum capacity (FAN Min) of the connector shall be determined by referring to the corresponding single appliance table. For Type B double-wall connectors, Table 5-8 shall be used. For single-wall connectors, Table 5-9 shall be used. The height (H) and lateral (L) shall be measured according to the procedures for a single appliance vent, as if the other appliances were not present.

TABLE 5-7
Vent Connector Maximum Length
[NFPA 54: Table 13.2.2]

Connector Diameter Maximum (in.)	Connector Horizontal Length (ft.)
3	4-1/2
4	6
5	7-1/2
6	9
7	10-1/2
8	12
9	13-1/2
10	15
12	18
14	21
16	24
18	27
20	30
22	33
24	36

For SI units, 1 in. = 25.4 mm; 1 ft = 0.305 m.
[NFPA 54 Table 13.2.2]

511.2.4 Where the vent connectors are combined prior to entering the vertical portion of the common vent to form a common vent manifold, the size of the common vent manifold and the common vent shall be determined by applying a 10 percent reduction (.90 x maximum common vent capacity) to the Common Vent Capacity part of the common vent tables. The length of the common vent connector manifold (LM) shall not exceed 18 in./in. (180 mm/mm) of common vent connector manifold diameter (D). (See Part II-Figure G.1(k).) [NFPA 54: 13.2.4]

511.2.5 Where the common vertical vent is offset, the maximum capacity of the common vent shall be reduced in accordance with Section 511.2.6, and the horizontal length of the common vent offset shall not exceed 18 in./in. (180 mm/mm) of common vent diameter. [NFPA 54: 13.2.5]

511.2.6 For each elbow up to and including 45 degrees in the common vent, the maximum common vent capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees up to and including 90 degrees, the maximum common vent capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54: 13.2.6]

511.2.7 The vent connector capacities listed

in the common vent sizing tables include allowance for two 90-degree elbows. For each additional elbow up to and including 45 degrees, the maximum vent connector capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees up to and including 90 degrees, the maximum vent connector capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54: 13.2.7]

511.2.8 Common Vent Minimum Size. The cross-sectional area of the common vent shall be equal to or greater than the cross-sectional area of the largest connector. [NFPA 54:13.2.8]

511.2.9 Tee and Wye Fittings. Tee and wye fittings connected to a common vent shall be considered as part of the common vent and constructed of materials consistent with that of the common vent. [NFPA 54:13.2.9]

511.2.10 At the point where tee or wye fittings connect to a common vent, the opening size of the fitting shall be equal to the size of the common vent. Such fittings shall not be prohibited from having reduced size openings at the point of connection of appliance vent connectors. [NFPA 54: 13.2.10]

511.2.11 Sea level input ratings shall be used when determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation. [NFPA 54: 13.2.11]

511.2.12 The connector rise (R) for each appliance connector shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together. [NFPA 54: 13.2.12]

511.2.13 For multiple units of gas utilization equipment all located on one floor, available total height (H) shall be measured from the highest draft hood outlet or flue collar up to the level of the outlet of the common vent. [NFPA 54: 13.2.13]

511.2.14 For multistory installations, available total height (H) for each segment of the system shall be the vertical distance between the highest draft hood outlet or flue collar entering that segment and the centerline of the next higher interconnection tee. (See Part II-Figure G.1(j).) [NFPA 54: 13.2.14]

511.2.15 The size of the lowest connector and of the vertical vent leading to the lowest interconnection of a multistory system shall be in accordance with Tables 5-8 or 5-9 for available total height (H) up to the lowest interconnection. (See Part II-Figure G.1(n).) [NFPA 54: 13.2.15]

511.2.16 Where used in multistory systems, vertical common vents shall be Type B double-wall and shall be installed with a listed vent cap. [NFPA 54: 13.2.16]

511.2.17 Offsets in multistory common vent systems shall be limited to a single offset in each system, and systems with an offset shall comply with all of the following: [NFPA 54: 13.2.17]

- (1) The offset angle shall not exceed 45 degrees from vertical.
- (2) The horizontal length of the offset shall not exceed 18 inches for each inch (180 mm/mm) of common vent diameter of the segment in which the offset is located.
- (3) For the segment of the common vertical vent containing the offset, the common vent capacity listed in the common venting tables shall be reduced by 20 percent (0.80 x maximum common vent capacity).
- (4) A multistory common vent shall not be reduced in size above the offset.

511.2.18 Where two or more appliances are connected to a vertical vent or chimney, the flow area of the largest section of vertical vent or chimney shall not exceed seven times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54: 13.2.18]

511.2.19 For appliances with more than one input rate, the minimum vent connector capacity (FAN Min) determined from the tables shall be less than the lowest appliance input rating, and the maximum vent connector capacity (FAN Max or NAT Max) determined from the table shall be greater than the highest appliance input rating. [NFPA 54: 13.2.19]

511.2.20 Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Tables 5-14 or 5-15 for Type B vents, with the maximum capacity reduced by 20 percent (0.80 maximum capacity) and the minimum capacity as shown in Tables 5-14 or 5-15. Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Sections 511.2.5 and 511.2.6. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90-degree turn at the bottom of the liner. [NFPA 54: 13.2.20]

511.2.21 Tables 5-14 and 5-15 shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent passing ←

through an unventilated enclosure or chase insulated to a value of not less than R8 shall not be considered to be exposed to the outdoors. Tables 5-19 and 5-20 shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following conditions are met: [NFPA 54:13.2.22]

- (1) Vent connector is Type B double-wall.
- (2) At least one appliance is draft-hood-equipped.
- (3) The combined appliance input rating is less than the maximum capacity given by Table 5-19 (for NAT + NAT) or Table 5-21 (for FAN + NAT).
- (4) The input rating of each space-heating appliance is greater than the minimum input rating given by Table 5-20 (for NAT + NAT) or Table 5-21 (for FAN + NAT).
- (5) The vent connector sizing is in accordance with Table 5-16.
- (6) Where these conditions cannot be met, an alternative venting design shall be used, such as a listed chimney lining system.

Exception: Vents serving listed appliances installed in accordance with the appliance manufacturers' installation instructions.

511.2.22 Vent connectors shall not be increased more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. Vent connectors for draft-hood-equipped appliances shall not be smaller than the draft hood outlet diameter. Where vent connector sizes determined from the tables for fan-assisted appliances are smaller than the flue collar diameter, the use of the smaller sizes shall be permitted provided that the installation complies with all of the following conditions: [NFPA 54: 13.2.24]

- (1) Vent connectors for fan-assisted appliance flue collars 12 inches (300 mm) in diameter or smaller are not reduced by more than one table size [e.g., 12 inches to 10 in. (300 mm to 250 mm) is a one-size reduction] and those larger than 12 inches (300 mm) in diameter are not reduced more than two table sizes [e.g., 24 inch to 20 inch (610 mm to 510 mm) is a two-size reduction].
- (2) Fan-assisted appliances are common vented with a draft-hood-equipped appliance.
- (3) The vent connector has a smooth interior wall.

511.2.23 All combinations of pipe sizes, single-wall, and double-wall metal pipe shall be allowed within any connector run or within the common vent, provided ALL

of the appropriate tables permit ALL of the desired sizes and types of pipe, as if they were used for the entire length of the subject connector or vent. Where single-wall and Type B double-wall metal pipes are used for vent connectors within the same venting system, the common vent must be sized using Tables 5-15 or 5-17 as appropriate. [NFPA 54: 13.2.25]

511.2.24 Where a table permits more than one diameter of pipe to be used for a connector or vent, all the permitted sizes shall be permitted to be used. [NFPA 54: 13.2.26]

511.2.25 Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. (See Part II Annex G.1.3.) [NFPA 54: 13.2.27]

511.2.26 Extrapolation beyond the table entries shall not be permitted. [NFPA 54: 13.2.28]

511.2.27 For vent heights lower than 6 feet and higher than shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54: 13.2.28]

512.0 Direct-Vent Equipment. Listed direct-vent gas utilization equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturers' instructions, and Section 510.8.3. [NFPA 54: 12.3.5]

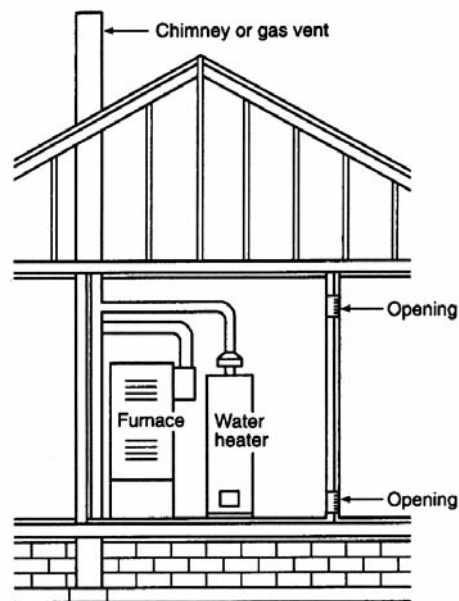


FIGURE 5-7 All Combustion Air from Indoor Spaces through Indoor Combustion Air Openings. [NFPA 54: Figure A.9.3.2.3(1)]

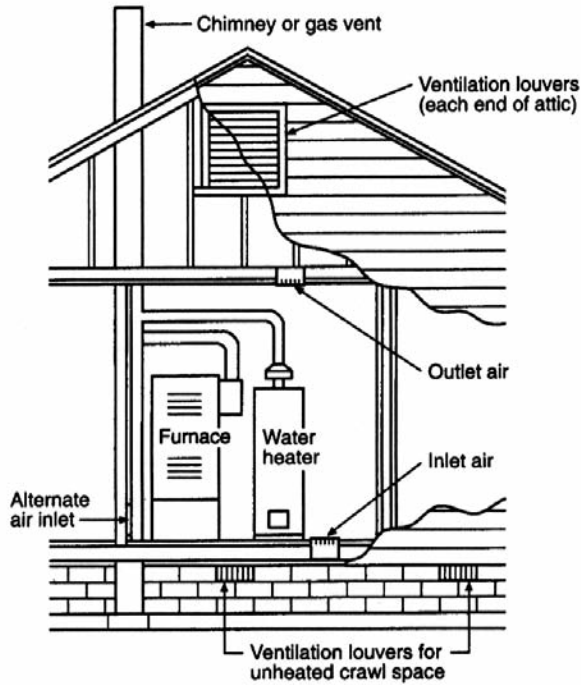


FIGURE 5-8 All Combustion Air from Outdoors - Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic. [NFPA 54: Figure A.9.3.3.1(a)]

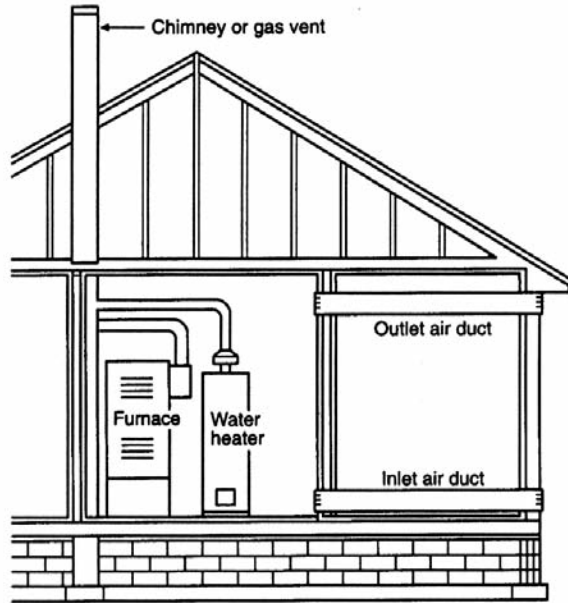


FIGURE 5-10 All Combustion Air from Outdoors through Horizontal Ducts. [NFPA 54: Figure A.9.3.3.1(2)]

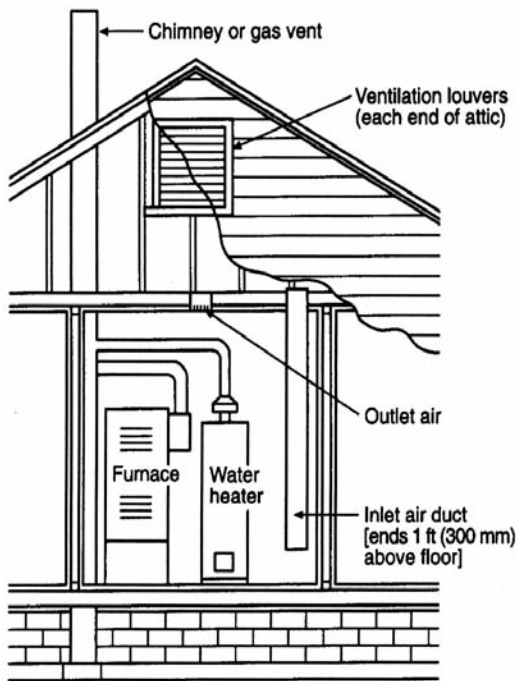


FIGURE 5-9 All Combustion Air from Outdoors through Ventilated Attic. [NFPA 54: Figure A.9.3.3.1(1)(b)]

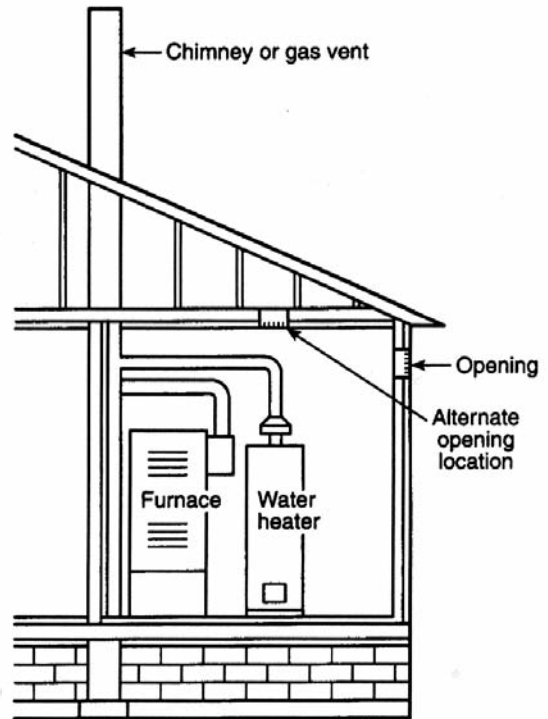


FIGURE 5-11 All Combustion Air from Outdoors through Single Combustion Air Opening. [NFPA 54: Figure A.9.3.3.2]

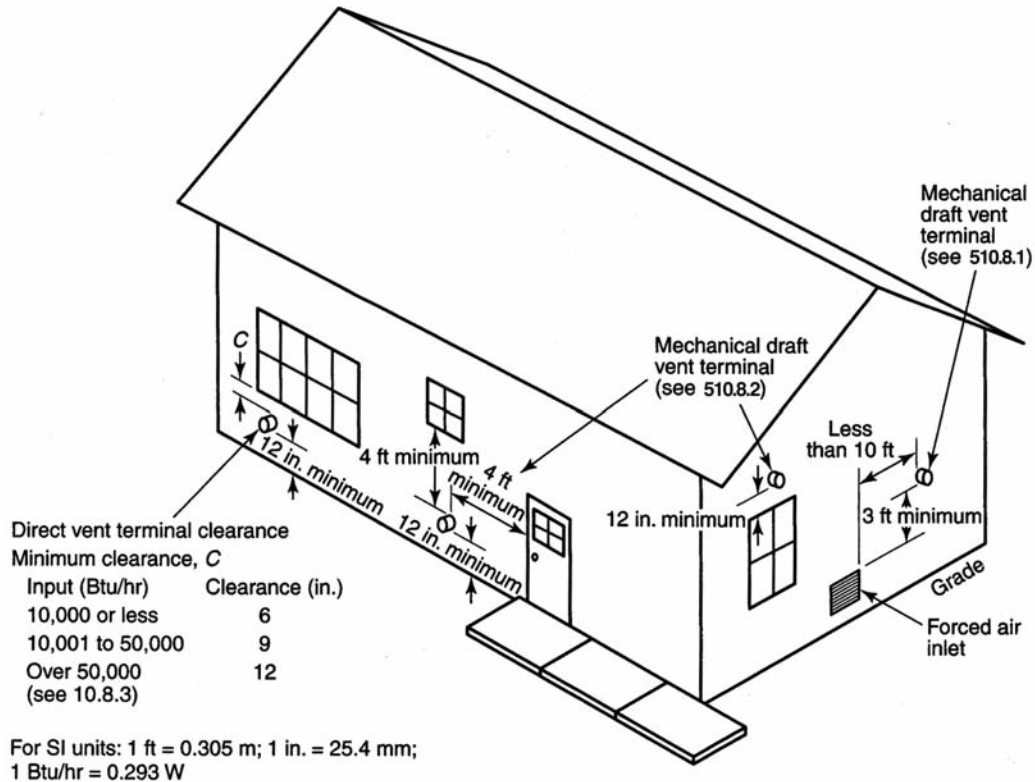


FIGURE 5-12 Exit Terminals of Mechanical Draft and Direct-Vent Venting Systems. [NFPA 54: Figure A.12.9]



99% Winter Design Temperatures for the Contiguous United States

This map is a necessarily generalized guide to temperatures in the contiguous United States. Temperatures shown for areas such as mountainous regions and large urban centers may not be accurate. The data used to develop this map are from the 1993 ASHRAE Handbook — Fundamentals (Chapter 24, Table 1: Climate Conditions for the United States).

For 99% winter design temperatures in Alaska, consult the ASHRAE Handbook — Fundamentals.

99% winter design temperatures for Hawaii are greater than 37°F.

FIGURE 5-13 Range of Winter Design Temperatures Used in Analyzing Exterior Masonry Chimneys in the United States.

Table 5-8 Type B Double-Wall Gas Vent

		Number of Appliances: Single																				
		Appliance Type: Category I																				
		Appliance Vent Connection: Connected Directly to Vent																				
		Vent Diameter — D (in.)																				
		3			4			5			6			7			8			9		
		Appliance Input Rating in Thousands of Btu per Hour																				
Height H (ft)	Lateral 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	0	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	897	470
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	63	543	370
	4	21	49	34	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	93	536	362
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205	93	413	273	110	530	354
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1006	537
	2	12	57	40	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	60	619	418
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	99	607	407
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	117	596	396
10	0	0	88	53	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1096	585
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	57	684	457
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	95	671	446
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	122	651	427
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1263	682
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	53	815	544
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	90	800	529
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	116	777	507
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	134	755	491
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430	0	1057	575	0	1384	732
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	531	346	41	711	470	50	917	612
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460	86	902	599
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443	112	877	576
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308	111	654	427	129	853	557
20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295	125	634	410	145	830	537	
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475	0	1173	650	0	1548	855
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	42	1072	700
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524	82	1055	688
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	107	1028	668
	15	33	64	NA	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	124	1002	648
	20	56	58	NA	53	132	90	66	237	154	80	374	237	102	542	343	119	743	473	139	977	628
30	NA	NA	NA	73	113	NA	88	214	NA	104	346	219	131	507	321	149	702	444	171	929	594	
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518	0	1297	708	0	1730	952
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	33	1276	813
	5	20	82	NA	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	77	1259	798
	10	26	76	NA	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	101	1230	773
	15	59	70	NA	42	158	NA	54	287	180	66	455	288	85	662	413	100	911	572	117	1203	747
	20	NA	NA	NA	50	149	NA	63	275	169	76	440	278	97	642	401	113	888	556	131	1176	722
30	NA	NA	NA	69	131	NA	84	250	NA	99	410	259	123	605	376	141	844	522	161	1125	670	
100	0	NA	NA	NA	0	218	NA	0	407	NA	0	665	400	0	997	560	0	1411	770	0	1908	1040
	2	NA	NA	NA	10	194	NA	12	354	NA	13	566	375	18	831	510	21	1155	700	25	1536	935
	5	NA	NA	NA	26	189	NA	33	347	NA	40	557	369	52	820	504	60	1141	692	71	1519	926
	10	NA	NA	NA	33	182	NA	43	335	NA	53	542	361	68	801	493	80	1118	679	94	1492	910
	15	NA	NA	NA	40	174	NA	50	321	NA	62	528	353	80	782	482	93	1095	666	109	1465	895
	20	NA	NA	NA	47	166	NA	59	311	NA	71	513	344	90	763	471	105	1073	653	122	1438	880
	30	NA	NA	NA	NA	NA	NA	78	290	NA	92	483	NA	115	726	449	131	1029	627	149	1387	849
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	147	428	NA	180	651	405	197	944	575	217	1288	787	

[NFPA 54 Table 13.1(a)]

Table 5-8 continued

		Number of Appliances: Single																										
		Appliance Type: Category I																										
		Appliance Vent Connection: Connected Directly to Vent																										
		Vent Diameter — D (in.)																										
		10			12			14			16			18			20			22			24					
		Appliance Input Rating in Thousands of Btu per Hour																										
Height H (ft)	Lateral L (ft)	FAN		NAT	FAN		NAT	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	Min	Max	Max	Min	Max	Max
6	0	0	1121	570	0	1645	850	0	2267	1170	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520			
	2	75	675	455	103	982	650	138	1346	890	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670			
	4	110	668	445	147	975	640	191	1338	880	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660			
	6	128	661	435	171	967	630	219	1330	870	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650			
8	0	0	1261	660	0	1858	970	0	2571	1320	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010			
	2	75	770	515	98	1124	745	130	1543	1020	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2260	401	4634	3050			
	5	115	758	503	154	1110	733	199	1528	1010	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040			
	8	137	746	490	180	1097	720	231	1514	1000	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030			
10	0	0	1377	720	0	2036	1060	0	2825	1450	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450			
	2	68	852	560	93	1244	850	124	1713	1130	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390			
	5	112	839	547	149	1229	829	192	1696	1105	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371			
	10	142	817	525	187	1204	795	238	1669	1080	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340			
15	0	0	1596	840	0	2380	1240	0	3323	1720	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10,393	5300			
	2	63	1019	675	86	1495	985	114	2062	1350	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080			
	5	105	1003	660	140	1476	967	182	2041	1327	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057			
	10	135	977	635	177	1446	936	227	2009	1289	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019			
20	0	0	1756	930	0	2637	1350	0	3701	1900	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11,753	6000			
	2	59	1150	755	81	1694	1100	107	2343	1520	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700			
	5	101	1133	738	135	1674	1079	174	2320	1498	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662			
	10	130	1105	710	172	1641	1045	220	2282	1460	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4660			
30	0	0	1977	1060	0	3004	1550	0	4252	2170	0	5725	2920	0	7420	3770	0	9341	4750	0	11,483	5850	0	13,848	7060			
	2	54	1351	865	74	2004	1310	98	2786	1800	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600			
	5	96	1332	851	127	1981	1289	164	2759	1775	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5552			
	10	125	1301	829	164	1944	1254	209	2716	1733	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471			
50	0	0	2231	1195	0	3441	1825	0	4934	2550	0	6711	3440	0	8774	4460	0	11,129	5635	0	13,767	6940	0	16,694	8430			
	2	41	1620	1010	66	2431	1513	86	3409	2125	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10,788	6860			
	5	90	1600	996	118	2406	1495	151	3380	2102	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10,737	6818			
	10	118	1567	972	154	2366	1466	196	3332	2064	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10,652	6749			
100	0	0	2491	1310	0	3925	2050	0	5729	2950	0	7914	4050	0	10,485	5300	0	13,454	6700	0	16,817	8600	0	20,578	10,300			
	2	30	1975	1170	44	3027	1820	72	4313	2550	95	5834	3500	120	7591	4600	138	9577	5800	169	11,803	7200	204	14,264	8800			
	5	82	1955	1159	107	3002	1803	136	4282	2531	172	5797	3475	208	7548	4566	245	9528	5769	293	11,748	7162	341	14,204	8756			
	10	108	1923	1142	142	2961	1775	180	4231	2500	223	5737	3434	268	7478	4509	318	9447	5717	374	11,658	7100	436	14,105	8683			

For SI units, 1 in. = 25.4 mm, 1 ft = 0.305 m, 1000 Btu/hr = 0.293 kW, 1 in.² = 645 mm².
[NFPA 54 Table 13.1(a)]

Table 5-9 Type B Double-Wall Vent

		Number of Appliances:												Single																							
		Appliance Type:												Category I																							
		Appliance Vent Connection:												Single Wall Metal Connector																							
		Vent Diameter — D (in.)																																			
		3				4				5				6				7				8				9				10				12			
		Appliance Input Rating in Thousands of Btu per Hour																																			
Height H (ft)	Lateral L (ft)	FAN		NAT		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	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	267	894	469	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	251	541	368	347	673	453	498	979	648									
	4	NA	NA	33	74	92	63	102	152	102	146	225	152	187	313	208	237	416	277	295	533	360	409	664	443	584	971	638									
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414	258	1002	536	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	246	617	417	339	768	513	486	1120	743									
	5	NA	NA	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311	305	604	404	418	754	500	598	1104	730									
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	202	844	449	253	1093	584	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	242	681	456	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	299	667	443	409	834	544	584	1224	825									
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388	195	966	523	244	1259	681	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	232	812	543	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	287	795	526	392	997	637	562	1469	963									
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	190	1053	573	238	1379	750	326	1751	927	473	2631	1346									
	2	37	74	50	56	148	99	78	248	165	113	375	248	144	528	344	182	708	468	227	914	611	309	1146	754	443	1689	1098									
	5	50	68	47	73	140	94	100	239	158	141	363	239	178	514	334	224	692	457	279	896	596	381	1126	734	547	1665	1074									
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	184	1168	647	229	1542	852	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	219	1069	698	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	269	1049	684	366	1324	846	524	1971	1283									
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724	948	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	209	1273	811	280	1615	1007	401	2426	1509									
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252	795	347	1591	991	496	2396	1490									
100	0	NA	NA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	765	418	1551	963	589	2347	1455									
	2	NA	NA	NA	112	148	NA	145	275	174	199	441	280	244	646	405	299	894	562	363	1183	736	481	1512	934	668	2299	1421									
	5	NA	NA	NA	NA	NA	NA	176	257	NA	236	420	267	285	622	389	345	866	543	415	1150	708	544	1473	906	741	2251	1387									
100	0	NA	NA	NA	49	214	NA	69	403	NA	100	659	395	131	991	555	166	1404	765	207	1900	1033	273	2479	1300	395	3912	2042									
	2	NA	NA	NA	51	192	NA	70	351	NA	98	563	373	125	828	508	158	1152	698	196	1532	933	259	1970	1168	371	3021	1817									
	5	NA	NA	NA	67	186	NA	90	342	NA	125	551	366	156	813	501	194	1134	688	240	1511	921	322	1945	1153	460	2990	1796									
100	0	NA	NA	NA	85	175	NA	113	324	NA	153	532	354	191	789	486	238	1104	672	293	1477	902	389	1905	1133	547	2938	1763									
	2	NA	NA	NA	132	162	NA	138	310	NA	188	511	343	230	764	473	281	1075	656	342	1443	884	447	1865	1110	618	2888	1730									
	5	NA	NA	NA	NA	NA	NA	168	295	NA	224	487	NA	270	739	458	325	1046	639	391	1410	864	507	1825	1087	690	2838	1696									
100	0	NA	NA	NA	NA	NA	NA	231	264	NA	301	448	NA	355	685	NA	418	988	NA	491	1343	824	631	1747	1041	834	2739	1627									
	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	540	584	NA	617	866	NA	711	1205	NA	895	1591	NA	1138	2547	1489									

For SI units, 1 in. = 25.4 mm, 1 ft = 0.305 m, 1000 Btu/hr = 0.293 kW, 1 in.² = 645 mm².
 [NFPA 54 Table 13.1(b)]

Table 5-10 Masonry Chimney

		Number of Appliances:															Single																																									
		Appliance Type:															Category I																																									
		Appliance Vent Connection:															Type B Double-Wall Connector																																									
		Type B Double-Wall Connector Diameter — <i>D</i> (in.)																																																								
		To be used with chimney areas within the size limits at bottom																																																								
		3			4			5			6			7			8			9			10			12																																
		Appliance Input Rating in Thousands of Btu per Hour																																																								
Height <i>H</i> (ft)	Lateral <i>L</i> (ft)	FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT																										
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max																									
6	2	NA	NA	28	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180	NA	NA	247	NA	NA	320	NA	NA	401	NA	NA	581	NA	NA	25	NA	NA	49	NA	NA	82	NA	NA	117	NA	NA	165	NA	NA	231	NA	NA	298	NA	NA	376	NA	NA	561			
	5	NA	NA	25	NA	NA	49	NA	NA	82	NA	NA	117	NA	NA	165	NA	NA	231	NA	NA	298	NA	NA	376	NA	NA	561	NA	NA	25	NA	NA	49	NA	NA	82	NA	NA	117	NA	NA	165	NA	NA	231	NA	NA	298	NA	NA	376	NA	NA	561			
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	198	NA	NA	266	84	590	350	100	728	446	139	1024	651	NA	NA	26	NA	NA	52	NA	NA	88	NA	NA	134	NA	NA	183	NA	NA	247	NA	NA	328	149	711	423	201	1007	640			
	5	NA	NA	26	NA	NA	52	NA	NA	88	NA	NA	134	NA	NA	183	NA	NA	247	NA	NA	328	149	711	423	201	1007	640	NA	NA	24	NA	NA	48	NA	NA	83	NA	NA	127	NA	NA	175	NA	NA	239	NA	NA	318	173	695	410	231	990	623			
10	2	NA	NA	31	NA	NA	61	NA	NA	103	NA	NA	162	NA	NA	221	68	519	298	82	655	388	98	810	491	136	1144	724	NA	NA	28	NA	NA	57	NA	NA	96	NA	NA	148	NA	NA	204	NA	NA	277	124	638	365	146	791	466	196	1124	712			
	5	NA	NA	28	NA	NA	57	NA	NA	96	NA	NA	148	NA	NA	204	NA	NA	277	124	638	365	146	791	466	196	1124	712	NA	NA	25	NA	NA	50	NA	NA	87	NA	NA	139	NA	NA	191	NA	NA	263	155	610	347	182	762	444	240	1093	668			
15	2	NA	NA	35	NA	NA	67	NA	NA	114	NA	NA	179	53	475	250	64	613	336	77	779	441	92	968	562	127	1376	841	NA	NA	35	NA	NA	62	NA	NA	107	NA	NA	164	NA	NA	231	99	594	313	118	759	416	139	946	533	186	1352	828			
	5	NA	NA	35	NA	NA	62	NA	NA	107	NA	NA	164	NA	NA	231	99	594	313	118	759	416	139	946	533	186	1352	828	NA	NA	28	NA	NA	55	NA	NA	97	NA	NA	153	NA	NA	216	126	565	296	148	727	394	173	912	567	229	1315	777			
20	2	NA	NA	38	NA	NA	74	NA	NA	124	NA	NA	201	51	522	274	61	678	375	73	867	491	87	1083	627	121	1548	953	NA	NA	25	NA	NA	50	NA	NA	89	NA	NA	141	NA	NA	201	NA	NA	281	171	698	375	198	880	485	259	1280	742			
	5	NA	NA	36	NA	NA	68	NA	NA	116	NA	NA	184	80	503	254	95	658	350	113	845	463	133	1059	597	179	1523	933	NA	NA	NA	NA	NA	60	NA	NA	107	NA	NA	172	NA	NA	237	122	627	332	143	811	440	167	1022	566	221	1482	879			
30	2	NA	NA	41	NA	NA	82	NA	NA	137	NA	NA	216	47	581	303	57	762	421	68	985	558	81	1240	717	111	1793	1112	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263	115	709	373	135	927	500	158	1176	648	210	1721	1025			
	5	NA	NA	NA	NA	NA	76	NA	NA	128	NA	NA	198	75	561	281	90	741	393	106	962	526	125	1216	683	169	1766	1094	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263	115	709	373	135	927	500	158	1176	648	210	1721	1025			
50	2	NA	NA	NA	NA	NA	92	NA	NA	161	NA	NA	251	NA	NA	351	51	840	477	61	1106	633	72	1413	812	99	2080	1243	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263	115	709	373	135	927	500	158	1176	648	210	1721	1025			
	5	NA	NA	NA	NA	NA	92	NA	NA	161	NA	NA	251	NA	NA	351	51	840	477	61	1106	633	72	1413	812	99	2080	1243	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263	115	709	373	135	927	500	158	1176	648	210	1721	1025			
Minimum internal area of chimney (in. ²)		12		19		28		38		50		63		78		95		132											NA	NA	NA	NA	NA	91	NA	NA	107	NA	NA	171	NA	NA	243	NA	NA	353	156	893	476	181	1139	621	239	1679	981			
		49		88		137		198		269		352		445		550		792													NA	NA	NA	NA	NA	91	NA	NA	107	NA	NA	171	NA	NA	243	NA	NA	353	156	893	476	181	1139	621	239	1679	981	
Maximum internal area of chimney (in. ²)		49		88		137		198		269		352		445		550		792													NA	NA	NA	NA	NA	91	NA	NA	107	NA	NA	171	NA	NA	243	NA	NA	353	156	893	476	181	1139	621	239	1679	981	
		49		88		137		198		269		352		445		550		792															NA	NA	NA	NA	NA	91	NA	NA	107	NA	NA	171	NA	NA	243	NA	NA	353	156	893	476	181	1139	621	239	1679

For SI units, 1 in. = 25.4 mm, 1 ft = 0.305 m, 1000 Btu/hr = 0.293 kW, 1 in.² = 645 mm².
 [NFPA 54 Table 13.1(c)]

Table 5-11 Masonry Chimney

		Number of Appliances: Single																																			
		Appliance Type: Category I																																			
		Appliance Vent Connection: Single-Wall Metal Connector																																			
Height <i>H</i> (ft)		Lateral <i>L</i> (ft)		Single-Wall Metal Connector Diameter — <i>D</i> (in.) To be used with chimney areas within the size limits at bottom																																	
				3			4			5			6			7			8			9			10			12									
				Appliance Input Rating in Thousands of Btu per Hour																																	
		FAN		NAT		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	Min	Max	Max	Min	Max	Max	Min	Max	Max						
6	2	NA	NA	28	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180	NA	NA	247	NA	NA	319	NA	NA	400	NA	NA	580	NA	NA	580						
	5	NA	NA	25	NA	NA	48	NA	NA	81	NA	NA	116	NA	NA	164	NA	NA	230	NA	NA	297	NA	NA	375	NA	NA	560	NA	NA	560						
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	197	NA	NA	265	NA	NA	349	382	725	445	549	1021	650	NA	NA	650						
	5	NA	NA	26	NA	NA	51	NA	NA	87	NA	NA	133	NA	NA	182	NA	NA	246	NA	NA	327	NA	NA	422	673	1003	638	NA	NA	638						
	8	NA	NA	23	NA	NA	47	NA	NA	82	NA	NA	126	NA	NA	174	NA	NA	237	NA	NA	317	NA	NA	408	747	985	621	NA	NA	621						
10	2	NA	NA	31	NA	NA	61	NA	NA	102	NA	NA	161	NA	NA	220	216	518	297	271	654	387	373	808	490	536	1142	722	NA	NA	722						
	5	NA	NA	28	NA	NA	56	NA	NA	95	NA	NA	147	NA	NA	203	NA	NA	276	334	635	364	459	789	465	657	1121	710	NA	NA	710						
	10	NA	NA	24	NA	NA	49	NA	NA	86	NA	NA	137	NA	NA	189	NA	NA	261	NA	NA	345	547	758	441	771	1088	665	NA	NA	665						
15	2	NA	NA	35	NA	NA	67	NA	NA	113	NA	NA	178	166	473	249	211	611	335	264	776	440	362	965	560	520	1373	840	NA	NA	840						
	5	NA	NA	32	NA	NA	61	NA	NA	106	NA	NA	163	NA	NA	230	261	591	312	325	755	414	444	942	531	637	1348	825	NA	NA	825						
	10	NA	NA	27	NA	NA	54	NA	NA	96	NA	NA	151	NA	NA	214	NA	NA	294	392	722	392	531	907	504	749	1309	774	NA	NA	774						
	15	NA	NA	NA	NA	NA	46	NA	NA	87	NA	NA	138	NA	NA	198	NA	NA	278	452	692	372	606	873	481	841	1272	738	NA	NA	738						
20	2	NA	NA	38	NA	NA	73	NA	NA	123	NA	NA	200	163	520	273	206	675	374	258	864	490	252	1079	625	508	1544	950	NA	NA	950						
	5	NA	NA	35	NA	NA	67	NA	NA	115	NA	NA	183	NA	NA	252	255	655	348	317	842	461	433	1055	594	623	1518	930	NA	NA	930						
	10	NA	NA	NA	NA	NA	59	NA	NA	105	NA	NA	170	NA	NA	235	312	622	330	382	806	437	517	1016	562	733	1475	875	NA	NA	875						
	15	NA	NA	NA	NA	NA	NA	NA	NA	95	NA	NA	156	NA	NA	217	NA	NA	311	442	773	414	591	979	539	823	1434	835	NA	NA	835						
	20	NA	NA	NA	NA	NA	NA	NA	NA	80	NA	NA	144	NA	NA	202	NA	NA	292	NA	NA	392	663	944	510	911	1394	800	NA	NA	800						
30	2	NA	NA	41	NA	NA	81	NA	NA	136	NA	NA	215	158	578	302	200	759	420	249	982	556	340	1237	715	489	1789	1110	NA	NA	1110						
	5	NA	NA	NA	NA	NA	75	NA	NA	127	NA	NA	196	NA	NA	279	245	737	391	306	958	524	417	1210	680	600	1760	1090	NA	NA	1090						
	10	NA	NA	NA	NA	NA	66	NA	NA	113	NA	NA	182	NA	NA	260	300	703	370	370	920	496	500	1168	644	708	1713	1020	NA	NA	1020						
	15	NA	NA	NA	NA	NA	NA	NA	NA	105	NA	NA	168	NA	NA	240	NA	NA	349	428	884	471	572	1128	615	798	1668	975	NA	NA	975						
	20	NA	NA	NA	NA	NA	NA	NA	NA	88	NA	NA	155	NA	NA	223	NA	NA	327	NA	NA	445	643	1089	585	883	1624	932	NA	NA	932						
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	182	NA	NA	281	NA	NA	408	NA	NA	544	1055	1539	865	NA	NA	865						
50	2	NA	NA	NA	NA	NA	91	NA	NA	160	NA	NA	250	NA	NA	350	191	837	475	238	1103	631	323	1408	810	463	2076	1240	NA	NA	1240						
	5	NA	NA	NA	NA	NA	NA	NA	NA	149	NA	NA	228	NA	NA	321	NA	NA	442	293	1078	593	398	1381	770	571	2044	1220	NA	NA	1220						
	10	NA	NA	NA	NA	NA	NA	NA	NA	136	NA	NA	212	NA	NA	301	NA	NA	420	355	1038	562	447	1337	728	674	1994	1140	NA	NA	1140						
	15	NA	NA	NA	NA	NA	NA	NA	NA	124	NA	NA	195	NA	NA	278	NA	NA	395	NA	NA	533	546	1294	695	761	1945	1090	NA	NA	1090						
	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	180	NA	NA	258	NA	NA	370	NA	NA	504	616	1251	660	844	1898	1040	NA	NA	1040						
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	318	NA	NA	458	NA	NA	610	1009	1805	970	NA	NA	970						
Minimum internal area of chimney (in. ²)				12				19				28				38				50				63				78				95				132	
Maximum internal area of chimney (in. ²)				49				88				137				198				269				352				445				550				792	

For SI units, 1 in. = 25.4 mm, 1 ft = 0.305 m, 1000 Btu/hr = 0.293 kW, 1 in.² = 645 mm².
 [NFPA 54 Table 13.1(d)]

Table 5-12 Single-Wall Metal Pipe or Type B Asbestos Cement Vent

		Number of Appliances:		Single					
		Appliance Type:		Draft Hood-Equipped					
		Appliance Vent Connection:		Connected Directly to Pipe or Vent					
Height <i>H</i> (ft)	Lateral <i>L</i> (ft)	Diameter – <i>D</i> (in.)							
		To be used with chimney areas within the size limits at bottom							
		3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
Maximum Appliance Input Rating in Thousands of Btu per Hour									
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
	10	24	49	86	131	180	250	406	625
10	0	45	84	138	202	279	372	606	912
	2	35	67	111	168	233	311	505	760
	5	32	61	104	153	215	289	480	724
	10	27	54	94	143	200	274	455	700
	15	NA	46	84	130	186	258	432	666
15	0	49	91	151	223	312	420	684	1040
	2	39	72	122	186	260	350	570	865
	5	35	67	110	170	240	325	540	825
	10	30	58	103	158	223	308	514	795
	15	NA	50	93	144	207	291	488	760
	20	NA	NA	82	132	195	273	466	726
20	0	53	101	163	252	342	470	770	1190
	2	42	80	136	210	286	392	641	990
	5	38	74	123	192	264	364	610	945
	10	32	65	115	178	246	345	571	910
	15	NA	55	104	163	228	326	550	870
	20	NA	NA	91	149	214	306	525	832
30	0	56	108	183	276	384	529	878	1370
	2	44	84	148	230	320	441	730	1140
	5	NA	78	137	210	296	410	694	1080
	10	NA	68	125	196	274	388	656	1050
	15	NA	NA	113	177	258	366	625	1000
	20	NA	NA	99	163	240	344	596	960
	30	NA	NA	NA	NA	192	295	540	890
50	0	NA	120	210	310	443	590	980	1550
	2	NA	95	171	260	370	492	820	1290
	5	NA	NA	159	234	342	474	780	1230
	10	NA	NA	146	221	318	456	730	1190
	15	NA	NA	NA	200	292	407	705	1130
	20	NA	NA	NA	185	276	384	670	1080
	30	NA	NA	NA	NA	222	330	605	1010

For SI units, 1 in. = 25.4 mm, 1 ft = 0.305 m, 1000 Btu/hr = 0.293 kW, 1 in.² = 645 mm².
[NFPA 54 Table 13.1(e)]

Table 5-13 Exterior Masonry Chimney

		Number of Appliances:		Single					
		Appliance Type:		NAT					
		Appliance Vent Connection:		Type B Double-Wall Connector					
SPECIAL USE: Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu per Hour									
Vent Height <i>H</i> (ft)	Internal Area of Chimney (in. ²)								
	12	19	28	38	50	63	78	113	
Local 99% winter design temperature: 37°F or greater									
6	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0	0
20	NA	NA	123	190	249	184	0	0	0
30	NA	NA	NA	NA	NA	393	334	0	0
50	NA	NA	NA	NA	NA	NA	NA	NA	579
Local 99% winter design temperature: 27°F to 36°F									
6	0	0	68	116	156	180	212	266	
8	0	0	82	127	167	187	214	263	
10	0	51	97	141	183	201	225	265	
15	NA	NA	NA	NA	233	253	274	305	
20	NA	NA	NA	NA	NA	307	330	362	
30	NA	NA	NA	NA	NA	419	445	485	
50	NA	NA	NA	NA	NA	NA	NA	763	
Local 99% winter design temperature: 17°F to 26°F									
6	NA	NA	NA	NA	NA	215	259	349	
8	NA	NA	NA	NA	197	226	264	352	
10	NA	NA	NA	NA	214	245	278	358	
15	NA	NA	NA	NA	NA	296	331	398	
20	NA	NA	NA	NA	NA	352	387	457	
30	NA	NA	NA	NA	NA	NA	507	581	
50	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: 5°F to 16°F									
6	NA	NA	NA	NA	NA	NA	NA	416	
8	NA	NA	NA	NA	NA	NA	312	423	
10	NA	NA	NA	NA	NA	289	331	430	
15	NA	NA	NA	NA	NA	NA	393	485	
20	NA	NA	NA	NA	NA	NA	450	547	
30	NA	NA	NA	NA	NA	NA	NA	682	
50	NA	NA	NA	NA	NA	NA	NA	972	
Local 99% winter design temperature: -10°F to 4°F									
6	NA	NA	NA	NA	NA	NA	NA	484	
8	NA	NA	NA	NA	NA	NA	NA	494	
10	NA	NA	NA	NA	NA	NA	NA	513	
15	NA	NA	NA	NA	NA	NA	NA	586	
20	NA	NA	NA	NA	NA	NA	NA	650	
30	NA	NA	NA	NA	NA	NA	NA	805	
50	NA	NA	NA	NA	NA	NA	NA	1003	
Local 99% winter design temperature: -11°F or lower Not recommended for any vent configurations									

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW, °C = (°F - 32)/1.8.
 Note: See Figure G.2.4 for a map showing local 99 percent winter design temperatures in the United States.
 [NFPA 54 Table 13.1(f)]

Table 5-14 Type B Double-Wall Vent

Number of Appliances:	Two or More
Appliance Type:	Category I
Appliance Vent Connection:	Type B Double-Wall Connector

Vent Connector Capacity

Vent Connector Height <i>H</i> (ft)		Rise <i>R</i> (ft)		Type B Double-Wall Vent and Connector Diameter — <i>D</i> (in.)																																	
				3			4			5			6			7			8			9			10												
				Appliance Input Rating Limits in Thousands of Btu per Hour																																	
		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	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	109	376	237	128	466	289	152	526	345	177	612	411	207	756	495			
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168	95	333	220	112	424	282	131	526	345	157	636	421	187	792	515	217	908	599			
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189	97	363	248	114	463	317	134	575	386	164	701	461	194	847	566	224	993	661			
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148	100	320	194	118	408	248	138	507	303	163	615	408	188	723	474	213	831	549			
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175	103	356	230	121	454	294	141	564	358	171	672	447	196	780	512	221	888	588			
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	123	492	330	143	612	402	171	738	497	196	846	566	221	942	624			
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154	106	341	200	125	436	257	146	542	314	171	650	429	196	758	507	221	866	575			
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182	109	374	238	128	479	305	149	596	372	176	726	497	196	834	566	221	934	624			
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205	111	402	268	131	515	342	152	642	417	181	786	527	206	894	607	231	990	661			
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163	110	389	214	134	493	273	162	609	333	192	741	497	222	879	588	252	1017	697			
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193	112	419	253	137	532	323	165	658	394	197	807	547	227	938	637	257	1075	747			
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218	115	445	286	140	565	365	167	700	444	202	856	576	232	1005	697	262	1133	797			
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171	107	436	224	131	552	285	158	681	347	188	812	527	218	938	627	248	1064	747			
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202	110	463	265	134	587	339	161	725	414	193	854	563	223	980	677	253	1122	807			
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228	113	486	300	137	618	383	164	764	466	208	900	607	233	1030	727	263	1180	857			
30	1	20	62	33	31	113	59	45	181	93	60	288	134	83	391	182	103	512	238	125	649	305	151	802	372	181	920	597	206	1038	707	232	1146	837			
	2	21	64	39	33	118	70	47	190	110	62	299	158	85	408	215	105	535	282	129	679	360	155	840	439	186	976	647	211	1094	787	237	1204	887			
	3	22	66	44	34	123	79	48	198	124	64	309	178	88	423	242	108	555	317	132	706	405	158	874	494	191	1010	697	222	1260	937	242	1260	937			
50	1	19	71	36	30	133	64	43	216	101	57	349	145	78	477	197	97	627	257	120	797	330	144	984	403	174	1104	538	199	1204	538	224	1254	538			
	2	21	73	43	32	137	76	45	223	119	59	358	172	81	490	234	100	645	306	123	820	392	148	1014	478	179	1154	538	204	1254	538	229	1304	538			
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263	103	661	343	126	842	441	151	1043	538	184	1204	538	209	1354	538	234	1354	538			
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204	91	810	266	112	1038	341	135	1285	417	160	1485	494	185	1635	555	209	1785	633			
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242	94	822	316	115	1054	405	139	1306	494	165	1535	555	194	1735	633	219	1835	717			
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272	97	834	355	118	1069	455	142	1327	555	174	1585	633	199	1785	717	224	1885	797			

Common Vent Capacity

Vent Height <i>H</i> (ft)		Type B Double-Wall Common Vent Diameter — <i>D</i> (in.)																							
		4			5			6			7			8			9			10					
		Combined Appliance Input Rating in Thousands of Btu per Hour																							
		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	FAN +FAN	FAN +NAT	NAT +NAT
6	92	81	65	140	116	103	204	161	147	309	248	200	404	314	260	547	434	335	672	520	410				
8	101	90	73	155	129	114	224	178	163	339	275	223	444	348	290	602	480	378	740	577	465				
10	110	97	79	169	141	124	243	194	178	367	299	242	477	377	315	649	522	405	800	627	495				
15	125	112	91	195	164	144	283	228	206	427	352	280	556	444	365	753	612	465	924	733	565				
20	136	123	102	215	183	160	314	255	229	475	394	310	621	499	405	842	688	523	1035	826	640				
30	152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	979	808	605	1209	975	740				
50	167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1164	977	705	1451	1188	860				
100	175	163	NA	311	277	NA	489	421	NA	751	658	479	1025	873	625	1408	1215	800	1784	1502	975				

[NFPA 54 Table 13.2(a)]

Table 5-14 *Continued*

		Number of Appliances: Two or More																				
		Appliance Type: Category I																				
		Appliance Vent Connection: Type B Double-Wall Connector																				
		Type B Double-Wall Vent and Connector Diameter — <i>D</i> (in.)																				
		12			14			16			18			20			22			24		
		Appliance Input Rating Limits in Thousands of Btu per Hour																				
Vent Height <i>H</i> (ft)	Connector Rise <i>R</i> (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	4861	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

Common Vent Capacity

		Type B Double-Wall Common Vent Diameter — <i>D</i> (in.)																				
		12			14			16			18			20			22			24		
		Combined Appliance Input Rating in Thousands of Btu per Hour																				
Vent Height <i>H</i> (ft)		FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT
		+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+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	10,681	8648	5920	13,004	10,499	7200	

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
[NFPA 54 Table 13.2(a)]

Table 5-15 Type B Double-Wall Vent

		Number of Appliances:	Two or More
		Appliance Type:	Category I
		Appliance Vent Connection:	Single-Wall Metal Connector

Vent Connector Capacity

Vent Height <i>H</i> (ft)		Connector Rise <i>R</i> (ft)		Single-Wall Metal Vent Connector Diameter — <i>D</i> (in.)																									
				3			4			5			6			7			8			9			10				
				Appliance Input Rating Limits in Thousands of Btu per Hour																									
		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	Min	Max	Max	Min	Max	Max	
6	1	NA	NA	26	NA	NA	46	NA	NA	71	NA	NA	102	207	223	140	262	293	183	325	373	234	447	463	286				
	2	NA	NA	31	NA	NA	55	NA	NA	85	168	182	123	215	251	167	271	331	219	334	422	281	458	524	344				
	3	NA	NA	34	NA	NA	62	121	131	95	175	198	138	222	273	188	279	361	247	344	462	316	468	574	385				
8	1	NA	NA	27	NA	NA	48	NA	NA	75	NA	NA	106	226	240	145	285	316	191	352	403	244	481	502	299				
	2	NA	NA	32	NA	NA	57	125	126	89	184	193	127	234	266	173	293	353	228	360	450	292	492	560	355				
	3	NA	NA	35	NA	NA	64	130	138	100	191	208	144	241	287	197	302	381	256	370	489	328	501	609	400				
10	1	NA	NA	28	NA	NA	50	119	121	77	182	186	110	240	253	150	302	335	196	372	429	252	506	534	308				
	2	NA	NA	33	84	85	59	124	134	91	189	203	132	248	278	183	311	369	235	381	473	302	517	589	368				
	3	NA	NA	36	89	91	67	129	144	102	197	217	148	257	299	203	320	398	265	391	511	339	528	637	413				
15	1	NA	NA	29	79	87	52	116	138	81	177	214	116	238	291	158	312	380	208	397	482	266	556	596	324				
	2	NA	NA	34	83	94	62	121	150	97	185	230	138	246	314	189	321	411	248	407	522	317	568	646	387				
	3	NA	NA	39	87	100	70	127	160	109	193	243	157	255	333	215	331	438	281	418	557	360	579	690	437				
20	1	49	56	30	78	97	54	115	152	84	175	238	120	233	325	165	306	425	217	390	538	276	546	664	336				
	2	52	59	36	82	103	64	120	163	101	182	252	144	243	346	197	317	453	259	400	574	331	558	709	403				
	3	55	62	40	87	107	72	125	172	113	190	264	164	252	363	223	326	476	294	412	607	375	570	750	457				
30	1	47	60	31	77	110	57	112	175	89	169	278	129	226	380	175	296	497	230	378	630	294	528	779	358				
	2	51	62	37	81	115	67	117	185	106	177	290	152	236	397	208	307	521	274	389	662	349	541	819	425				
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235	316	542	309	400	690	394	555	855	482				
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188	284	604	245	364	768	314	507	951	384				
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223	294	623	293	376	793	375	520	983	458				
	3	52	72	45	83	136	82	119	221	123	178	353	186	235	486	252	304	640	331	387	816	423	535	1013	518				
100	1	45	79	34	71	150	61	104	249	98	153	424	140	205	585	192	269	774	249	345	993	321	476	1236	393				
	2	48	80	41	75	153	73	110	255	115	160	428	167	212	593	228	279	788	299	358	1011	383	490	1259	469				
	3	51	81	46	79	157	85	114	260	129	168	433	190	222	603	256	289	801	339	368	1027	431	506	1280	527				

Common Vent Capacity

Vent Height <i>H</i> (ft)		Type B Double-Wall Vent Diameter — <i>D</i> (in.)																				
		4			5			6			7			8			9			10		
		Combined Appliance Input Rating in Thousands of Btu per Hour																				
		FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT
		+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT
6	NA	78	64	NA	113	99	200	158	144	304	244	196	398	310	257	541	429	332	665	515	407	
8	NA	87	71	NA	126	111	218	173	159	331	269	218	436	342	285	592	473	373	730	569	460	
10	NA	94	76	163	137	120	237	189	174	357	292	236	467	369	309	638	512	398	787	617	487	
15	121	108	88	189	159	140	275	221	200	416	343	274	544	434	357	738	599	456	905	718	553	
20	131	118	98	208	177	156	305	247	223	463	383	302	606	487	395	824	673	512	1013	808	626	
30	145	132	113	236	202	180	350	286	257	533	446	349	703	570	459	958	790	593	1183	952	723	
50	159	145	128	268	233	208	406	337	296	622	529	410	833	686	535	1139	954	689	1418	1157	838	
100	166	153	NA	297	263	NA	469	398	NA	726	633	464	999	846	606	1378	1185	780	1741	1459	948	

[NFPA 54 Table 13.2(b)]

Table 5-16 Masonry Chimney

		Number of Appliances:	Two or More
		Appliance Type:	Category I
		Appliance Vent Connection:	Type B Double-Wall Connector

Vent Connector Capacity

Vent Height <i>H</i> (ft)		Connector Rise <i>R</i> (ft)		Type B Double-Wall Vent Connector Diameter — <i>D</i> (in.)																																															
				3						4						5						6						7						8						9						10					
				Appliance Input Rating Limits in Thousands of Btu per Hour																																															
		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	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max														
6	1	24	33	21	39	62	40	52	106	67	65	194	101	87	274	141	104	370	201	124	479	253	145	599	319	145	599	319	145	599	319	145	599	319	145	599	319														
	2	26	43	28	41	79	52	53	133	85	67	230	124	89	324	173	107	436	232	127	562	300	148	694	378	148	694	378	148	694	378	148	694	378	148	694	378														
	3	27	49	34	42	92	61	55	155	97	69	262	143	91	369	203	109	491	270	129	633	349	151	795	439	151	795	439	151	795	439	151	795	439	151	795	439														
8	1	24	39	22	39	72	41	55	117	69	71	213	105	94	304	148	113	414	210	134	539	267	156	682	335	156	682	335	156	682	335	156	682	335	156	682	335														
	2	26	47	29	40	87	53	57	140	86	73	246	127	97	350	179	116	473	240	137	615	311	160	776	394	160	776	394	160	776	394	160	776	394	160	776	394														
	3	27	52	34	42	97	62	59	159	98	75	269	145	99	383	206	119	517	276	139	672	358	163	848	452	163	848	452	163	848	452	163	848	452	163	848	452														
10	1	24	42	22	38	80	42	55	130	71	74	232	108	101	324	153	120	444	216	142	582	277	165	739	348	165	739	348	165	739	348	165	739	348	165	739	348														
	2	26	50	29	40	93	54	57	153	87	76	261	129	103	366	184	123	498	247	145	652	321	168	825	407	168	825	407	168	825	407	168	825	407	168	825	407														
	3	27	55	35	41	105	63	58	170	100	78	284	148	106	397	209	126	540	281	147	705	366	171	893	463	171	893	463	171	893	463	171	893	463	171	893	463														
15	1	24	48	23	38	93	44	54	154	74	72	277	114	100	384	164	125	511	229	153	658	297	184	824	375	184	824	375	184	824	375	184	824	375	184	824	375														
	2	25	55	31	39	105	55	56	174	89	74	299	134	103	419	192	128	558	260	156	718	339	187	900	432	187	900	432	187	900	432	187	900	432	187	900	432														
	3	26	59	35	41	115	64	57	189	102	76	319	153	105	448	215	131	597	292	159	760	382	190	960	486	190	960	486	190	960	486	190	960	486	190	960	486														
20	1	24	52	24	37	102	46	53	172	77	71	313	119	98	437	173	123	584	239	150	752	312	180	943	397	180	943	397	180	943	397	180	943	397	180	943	397														
	2	25	58	31	39	114	56	55	190	91	73	335	138	101	467	199	126	625	270	153	805	354	184	1011	452	184	1011	452	184	1011	452	184	1011	452																	
	3	26	63	35	40	123	65	57	204	104	75	353	157	104	493	222	129	661	301	156	851	396	187	1067	505	187	1067	505	187	1067	505	187	1067	505																	
30	1	24	54	25	37	111	48	52	192	82	69	357	127	96	504	187	119	680	255	145	883	337	175	1115	432	175	1115	432	175	1115	432	175	1115	432	175	1115	432														
	2	25	60	32	38	122	58	54	208	95	72	376	145	99	531	209	122	715	287	149	928	378	179	1171	484	179	1171	484	179	1171	484	179	1171	484																	
	3	26	64	36	40	131	66	56	221	107	74	392	163	101	554	233	125	746	317	152	968	418	182	1220	535	182	1220	535	182	1220	535	182	1220	535																	
50	1	23	51	25	36	116	51	51	209	89	67	405	143	92	582	213	115	798	294	140	1049	392	168	1334	506	168	1334	506	168	1334	506	168	1334	506																	
	2	24	59	32	37	127	61	53	225	102	70	421	161	95	604	235	118	827	326	143	1085	433	172	1379	558	172	1379	558	172	1379	558																				
	3	26	64	36	39	135	69	55	237	115	72	435	180	98	624	260	121	854	357	147	1118	474	176	1421	611	176	1421	611	176	1421	611																				
100	1	23	46	24	35	108	50	49	208	92	65	428	155	88	640	237	109	907	334	134	1222	454	161	1589	596	161	1589	596	161	1589	596																				
	2	24	53	31	37	120	60	51	224	105	67	444	174	92	660	260	113	933	368	138	1253	497	165	1626	651	165	1626	651																							
	3	25	59	35	38	130	68	53	237	118	69	458	193	94	679	285	116	956	399	141	1282	540	169	1661	705	169	1661	705																							

Common Vent Capacity

Vent Height <i>H</i> (ft)		Minimum Internal Area of Masonry Chimney Flue (in. ²)																																															
		12						19						28						38						50						63						78						113					
		Combined Appliance Input Rating in Thousands of Btu per Hour																																															
		FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT															
		+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT															
6	NA	74	25	NA	119	46	NA	178	71	NA	257	103	NA	351	143	NA	458	188	NA	582	246	1041	853	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																
	8	NA	80	28	NA	130	53	NA	193	82	NA	279	119	NA	384	163	NA	501	218	724	636	278	1144	937	408	NA	NA	NA	NA	NA	NA	NA	NA																
	10	NA	84	31	NA	138	56	NA	207	90	NA	299	131	NA	409	177	606	538	236	776	686	302	1226	1010	454	NA	NA	NA	NA	NA	NA	NA	NA																
	15	NA	NA	36	NA	152	67	NA	233	106	NA	334	152	523	467	212	682	611	283	874	781	365	1374	1156	546	NA	NA	NA	NA	NA	NA	NA	NA																
20	NA	NA	41	NA	NA	75	NA	250	122	NA	368	172	565	508	243	742	668	325	955	858	419	1513	1286	648	NA	NA	NA	NA	NA	NA	NA	NA																	
30	NA	NA	NA	NA	NA	NA	NA	270	137	NA	404	198	615	564	278	816	747	381	1062	969	496	1702	1473	749	NA	NA	NA	NA	NA	NA	NA	NA																	
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	620	328	879	831	461	1165	1089	606	1905	1692	922	NA	NA	NA	NA	NA	NA	NA	NA																	
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA																

[NFPA 54 Table 13.2(c)]

Table 5-17 Masonry Chimney

		Number of Appliances: Two or More																											
		Appliance Type: Category I																											
		Appliance Vent Connection: Single-Wall Metal Connector																											
Vent Connector Capacity																													
		Single-Wall Metal Vent Connector Diameter — D (in.)																											
		3			4			5			6			7			8			9			10						
		Appliance Input Rating Limits in Thousands of Btu per Hour																											
Vent Height H (ft)	Connector Rise R (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	Min	Max	Max	Min	Max	Max	Min
6	1	NA	NA	21	NA	NA	39	NA	NA	66	179	191	100	231	271	140	292	366	200	362	474	252	499	594	316				
	2	NA	NA	28	NA	NA	52	NA	NA	84	186	227	123	239	321	172	301	432	231	373	557	299	509	696	376				
	3	NA	NA	34	NA	NA	61	134	153	97	193	258	142	247	365	202	309	491	269	381	634	348	519	793	437				
8	1	NA	NA	21	NA	NA	40	NA	NA	68	195	208	103	250	298	146	313	407	207	387	530	263	529	672	331				
	2	NA	NA	28	NA	NA	52	137	139	85	202	240	125	258	343	177	323	465	238	397	607	309	540	766	391				
	3	NA	NA	34	NA	NA	62	143	156	98	210	264	145	266	376	205	332	509	274	407	663	356	551	838	450				
10	1	NA	NA	22	NA	NA	41	130	151	70	202	225	106	267	316	151	333	434	213	410	571	273	558	727	343				
	2	NA	NA	29	NA	NA	53	136	150	86	210	255	128	276	358	181	343	489	244	420	640	317	569	813	403				
	3	NA	NA	34	97	102	62	143	166	99	217	277	147	284	389	207	352	530	279	430	694	363	580	880	459				
15	1	NA	NA	23	NA	NA	43	129	151	73	199	271	112	268	376	161	349	502	225	445	646	291	623	808	366				
	2	NA	NA	30	92	103	54	135	170	88	207	295	132	277	411	189	359	548	256	456	706	334	634	884	424				
	3	NA	NA	34	96	112	63	141	185	101	215	315	151	286	439	213	368	586	289	466	755	378	646	945	479				
20	1	NA	NA	23	87	99	45	128	167	76	197	303	117	265	425	169	345	569	235	439	734	306	614	921	387				
	2	NA	NA	30	91	111	55	134	185	90	205	325	136	274	455	195	355	610	266	450	787	348	627	986	443				
	3	NA	NA	35	96	119	64	140	199	103	213	343	154	282	481	219	365	644	298	461	831	391	639	1042	496				
30	1	NA	NA	24	86	108	47	126	187	80	193	347	124	259	492	183	338	665	250	430	864	330	600	1089	421				
	2	NA	NA	31	91	119	57	132	203	93	201	366	142	269	518	205	348	699	282	442	908	372	613	1145	473				
	3	NA	NA	35	95	127	65	138	216	105	209	381	160	277	540	229	358	729	312	452	946	412	626	1193	524				
50	1	NA	NA	24	85	113	50	124	204	87	188	392	139	252	567	208	328	778	287	417	1022	383	582	1302	492				
	2	NA	NA	31	89	123	60	130	218	100	196	408	158	262	588	230	339	806	320	429	1058	425	596	1346	545				
	3	NA	NA	35	94	131	68	136	231	112	205	422	176	271	607	255	349	831	351	440	1090	466	610	1386	597				
100	1	NA	NA	23	84	104	49	122	200	89	182	410	151	243	617	232	315	875	328	402	1181	444	560	1537	580				
	2	NA	NA	30	88	115	59	127	215	102	190	425	169	253	636	254	326	899	361	415	1210	488	575	1570	634				
	3	NA	NA	34	93	124	67	133	228	115	199	438	188	262	654	279	337	921	392	427	1238	529	589	1604	687				

Common Vent Capacity																														
		Minimum Internal Area of Masonry Chimney Flue (in. ²)																												
		12			19			28			38			50			63			78			113							
		Combined Appliance Input Rating in Thousands of Btu per Hour																												
Vent Height H (ft)	FAN		FAN		NAT		FAN		FAN		NAT		FAN		FAN		NAT		FAN		FAN		NAT		FAN		FAN		NAT	
	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT	+FAN	+NAT		
6	NA	NA	25	NA	118	45	NA	176	71	NA	255	102	NA	348	142	NA	455	187	NA	579	245	NA	846	NA						
8	NA	NA	28	NA	128	52	NA	190	81	NA	276	118	NA	380	162	NA	497	217	NA	633	277	1136	928	405						
10	NA	NA	31	NA	136	56	NA	205	89	NA	295	129	NA	405	175	NA	532	234	771	680	300	1216	1000	450						
15	NA	NA	36	NA	NA	66	NA	230	105	NA	335	150	NA	400	210	677	602	280	866	772	360	1359	1139	540						
20	NA	NA	NA	NA	NA	74	NA	247	120	NA	362	170	NA	503	240	765	661	321	947	849	415	1495	1264	640						
30	NA	NA	NA	NA	NA	NA	NA	NA	135	NA	398	195	NA	558	275	808	739	377	1052	957	490	1682	1447	740						
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	612	325	NA	821	456	1152	1076	600	1879	1672	910						
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	494	NA	NA	663	2006	1885	1046						

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
 [NFPA 54 Table 13.2(d)]

Table 5-18 Single-Wall Metal Pipe or Type B Asbestos Cement Vent

		Number of Appliances:	Two or More
		Appliance Type:	Draft Hood-Equipped
		Appliance Vent Connection:	Direct to Pipe or Vent

Vent Connector Capacity							
Total Vent Height <i>H</i> (ft)	Connector Rise <i>R</i> (ft)	Vent Connector Diameter — <i>D</i> (in.)					
		3	4	5	6	7	8
Maximum Appliance Input Rating in Thousands of Btu per Hour							
6–8	1	21	40	68	102	146	205
	2	28	53	86	124	178	235
	3	34	61	98	147	204	275
15	1	23	44	77	117	179	240
	2	30	56	92	134	194	265
	3	35	64	102	155	216	298
30 and up	1	25	49	84	129	190	270
	2	31	58	97	145	211	295
	3	36	68	107	164	232	321

Common Vent Capacity							
Total Vent Height <i>H</i> (ft)	Common Vent Diameter — <i>D</i> (in.)						
	4	5	6	7	8	10	12
Combined Appliance Input Rating in Thousands of Btu per Hour							
6	48	78	111	155	205	320	NA
8	55	89	128	175	234	365	505
10	59	95	136	190	250	395	560
15	71	115	168	228	305	480	690
20	80	129	186	260	340	550	790
30	NA	147	215	300	400	650	940
50	NA	NA	NA	360	490	810	1190

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
 Note: See Figure G.1(f) and Section 13.2.
 [NFPA 54 Table 13.2(e)]

Table 5-19 Exterior Masonry Chimney

		Number of Appliances:	Two or More
		Appliance Type:	NAT + NAT
		Appliance Vent Connection:	Type B Double-Wall Connector

SPECIAL USE: Combined Appliance Maximum Input Rating in Thousands of Btu per Hour								
Vent Height <i>H</i> (ft)	Internal Area of Chimney (in. ²)							
	12	19	28	38	50	63	78	113
6	25	46	71	103	143	188	246	NA
8	28	53	82	119	163	218	278	408
10	31	56	90	131	177	236	302	454
15	NA	67	106	152	212	283	365	546
20	NA	NA	NA	NA	NA	325	419	648
30	NA	NA	NA	NA	NA	NA	496	749
50	NA	NA	NA	NA	NA	NA	NA	922
100	NA	NA	NA	NA	NA	NA	NA	NA

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
 [NFPA 54 Table 13.2(f)]

Table 5-20 Exterior Masonry Chimney

		Number of Appliances:		Two or More					
		Appliance Type:		NAT + NAT					
		Appliance Vent Connection:		Type B Double-Wall Connector					
SPECIAL USE: Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu per Hour									
Vent Height <i>H</i> (ft)	Internal Area of Chimney (in. ²)								
	12	19	28	38	50	63	78	113	
Local 99% winter design temperature: 37°F or greater									
6	0	0	0	0	0	0	0	NA	
8	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	
15	NA	0	0	0	0	0	0	0	
20	NA	NA	NA	NA	NA	184	0	0	
30	NA	NA	NA	NA	NA	393	334	0	
50	NA	NA	NA	NA	NA	NA	NA	579	
100	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: 27°F to 36°F									
6	0	0	68	NA	NA	180	212	NA	
8	0	0	82	NA	NA	187	214	263	
10	0	51	NA	NA	NA	201	225	265	
15	NA	NA	NA	NA	NA	253	274	305	
20	NA	NA	NA	NA	NA	307	330	362	
30	NA	NA	NA	NA	NA	NA	445	485	
50	NA	NA	NA	NA	NA	NA	NA	763	
100	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: 17°F to 26°F									
6	NA	NA	NA	NA	NA	NA	NA	NA	
8	NA	NA	NA	NA	NA	NA	264	352	
10	NA	NA	NA	NA	NA	NA	278	358	
15	NA	NA	NA	NA	NA	NA	331	398	
20	NA	NA	NA	NA	NA	NA	387	457	
30	NA	NA	NA	NA	NA	NA	NA	581	
50	NA	NA	NA	NA	NA	NA	NA	862	
100	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: 5°F to 16°F									
6	NA	NA	NA	NA	NA	NA	NA	NA	
8	NA	NA	NA	NA	NA	NA	NA	NA	
10	NA	NA	NA	NA	NA	NA	NA	430	
15	NA	NA	NA	NA	NA	NA	NA	485	
20	NA	NA	NA	NA	NA	NA	NA	547	
30	NA	NA	NA	NA	NA	NA	NA	682	
50	NA	NA	NA	NA	NA	NA	NA	NA	
100	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: 4°F or lower Not recommended for any vent configurations									

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW, °C = (°F - 32)/1.8.
 Note: See Figure G.2.4 for a map showing local 99 percent winter design temperatures in the United States.
 [NFPA 54 Table 13.2(g)]

Table 5-21 Exterior Masonry Chimney

		Number of Appliances:		Two or More					
		Appliance Type:		FAN + NAT					
		Appliance Vent Connection:		Type B Double-Wall Connector					
SPECIAL USE: Combined Appliance Maximum Input Rating in Thousands of Btu per Hour									
Vent Height H (ft)	Internal Area of Chimney (in.²)								
	12	19	28	38	50	63	78	113	
6	74	119	178	257	351	458	582	853	
8	80	130	193	279	384	501	636	937	
10	84	138	207	299	409	538	686	1010	
15	NA	152	233	334	467	611	781	1156	
20	NA	NA	250	368	508	668	858	1286	
30	NA	NA	NA	404	564	747	969	1473	
50	NA	NA	NA	NA	NA	831	1089	1692	
100	NA	NA	NA	NA	NA	NA	NA	1921	

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
 [NFPA 54 Table 13.2(h)]

Table 5-22 Exterior Masonry Chimney

		Number of Appliances:		Two or More						
		Appliance Type:		FAN + NAT						
		Appliance Vent Connection:		Type B Double-Wall Connector						
SPECIAL USE: Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu per Hour										
Vent Height <i>H</i> (ft)	Internal Area of Chimney (in. ²)									
	12	19	28	38	50	63	78	113		
Local 99% winter design temperature: 37°F or greater										
6	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	
15	NA	0	0	0	0	0	0	0	0	
20	NA	NA	123	190	249	184	0	0	0	
30	NA	NA	NA	334	398	393	334	0	0	
50	NA	NA	NA	NA	NA	714	707	579	579	
100	NA	NA	NA	NA	NA	NA	NA	1600	1600	
Local 99% winter design temperature: 27°F to 36°F										
6	0	0	68	116	156	180	212	266	266	
8	0	0	82	127	167	187	214	263	263	
10	0	51	97	141	183	210	225	265	265	
15	NA	111	142	183	233	253	274	305	305	
20	NA	NA	187	230	284	307	330	362	362	
30	NA	NA	NA	330	319	419	445	485	485	
50	NA	NA	NA	NA	NA	672	705	763	763	
100	NA	NA	NA	NA	NA	NA	NA	1554	1554	
Local 99% winter design temperature: 17°F to 26°F										
6	0	55	99	141	182	215	259	349	349	
8	52	74	111	154	197	226	264	352	352	
10	NA	90	125	169	214	245	278	358	358	
15	NA	NA	167	212	263	296	331	398	398	
20	NA	NA	212	258	316	352	387	457	457	
30	NA	NA	NA	362	429	470	507	581	581	
50	NA	NA	NA	NA	NA	723	766	862	862	
100	NA	NA	NA	NA	NA	NA	NA	1669	1669	
Local 99% winter design temperature: 5°F to 16°F										
6	NA	78	121	166	214	252	301	416	416	
8	NA	94	135	182	230	269	312	423	423	
10	NA	111	149	198	250	289	331	430	430	
15	NA	NA	193	247	305	346	393	485	485	
20	NA	NA	NA	293	360	408	450	547	547	
30	NA	NA	NA	377	450	531	580	682	682	
50	NA	NA	NA	NA	NA	797	853	972	972	
100	NA	NA	NA	NA	NA	NA	NA	1833	1833	
Local 99% winter design temperature: -10°F to 4°F										
6	NA	NA	145	196	249	296	349	484	484	
8	NA	NA	159	213	269	320	371	494	494	
10	NA	NA	175	231	292	339	397	513	513	
15	NA	NA	NA	283	351	404	457	586	586	
20	NA	NA	NA	333	408	468	528	650	650	
30	NA	NA	NA	NA	NA	603	667	805	805	
50	NA	NA	NA	NA	NA	NA	955	1003	1003	
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Local 99% winter design temperature: -11°F or lower Not recommended for any vent configurations										

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm², 1 ft = 0.305 m, 1000 Btu per hr = 0.293 kW.
 Note: See Figure G.2.4 for a map showing local 99 percent winter design temperatures in the United States.
 [NFPA 54 Table 13.2(i)]

PART II

This is originally from NFPA 54, which contains additional references from the UPC.

Sizing of Venting Systems Serving Appliances Equipped with Draft Hoods, Category I Appliances, and Appliances Listed for Use with Type B Vents

G.1 Examples Using Single Appliance Venting Tables. See Figure G.1(a) through Figure G.1(n).

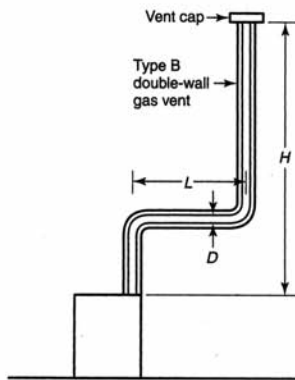


Table 5-8 is used when sizing Type B double-wall gas vent connected directly to the appliance.

Note: The appliance can be either Category I draft-hood-equipped or fan-assisted type.

FIGURE G.1(a) Type B Double-Wall Vent System Serving a Single Appliance With a Type B Double-Wall Vent.

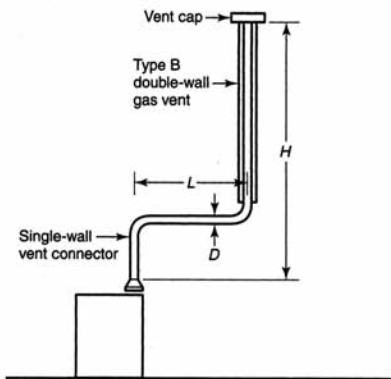


Table 5-9 is used when sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

Note: The appliance can be either Category I draft-hood-equipped or fan-assisted type.

FIGURE G.1(b) Type B Double-Wall Vent System Serving a Single Appliance With a Single-Wall Metal Vent Connector.

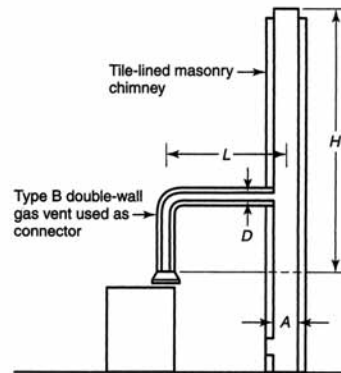


Table 5-10 is used when sizing a Type B double-wall gas vent connector attached to a tile-lined masonry chimney

Notes:

1. A is the equivalent cross-sectional area of the tile liner.
2. The appliance can be either Category I draft-hood-equipped or fan-assisted type.

FIGURE G.1(c) Vent System Serving a Single Appliance With a Masonry Chimney and a Type B Double-Wall Vent Connector.

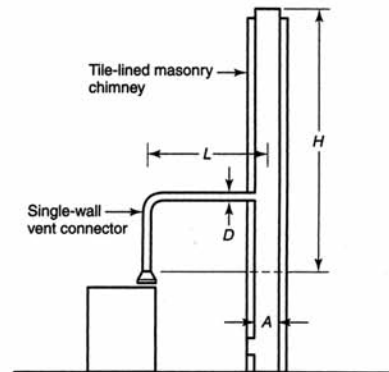


Table 5-11 is used when sizing a single-wall vent connector attached to a tile-lined masonry chimney.

Notes:

1. A is the equivalent cross-sectional area of the tile liner.
2. The appliance can be either Category I draft-hood-equipped or fan-assisted type.

FIGURE G.1(d) Vent System Serving a Single Appliance Using a Masonry Chimney and a Single-Wall Metal Vent Connector.

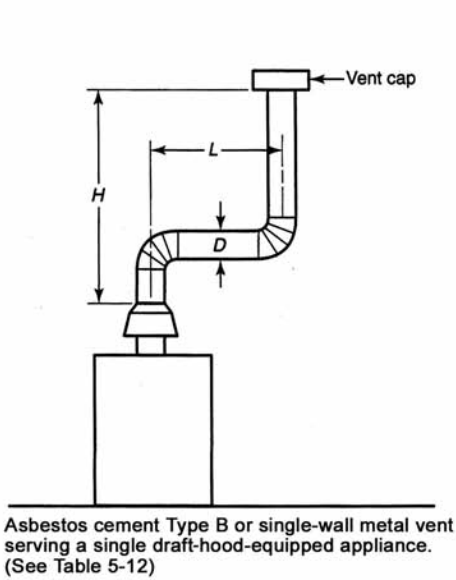


FIGURE G.1(e) Asbestos Cement Type B or Single-Wall Metal Vent System Serving a Single Draft-Hood-Equipped Appliance.

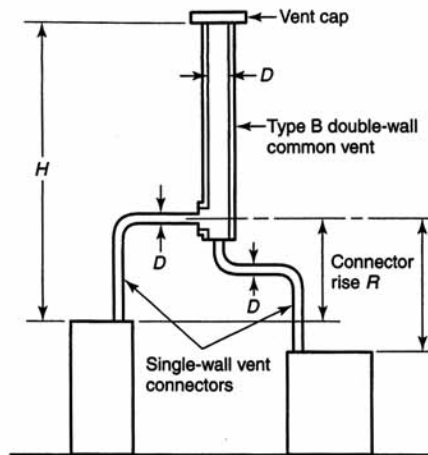


FIGURE G.1(g) Vent System Serving Two or More Appliances With Type B Double-Wall Vent and Single-Wall Metal Vent Connectors.

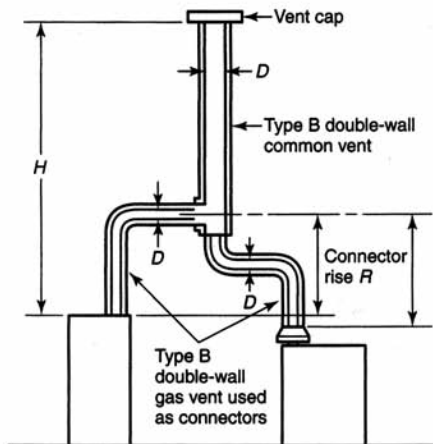


FIGURE G.1(f) Vent System Serving Two or More Appliances With Type B Double-Wall Vent and Type B Double-Wall Vent Connectors.

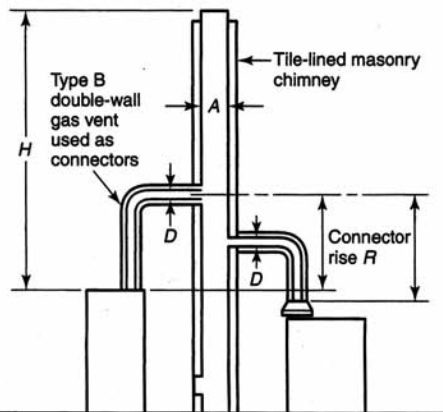


FIGURE G.1(h) Masonry Chimney Serving Two or More Appliances With Type B Double-Wall Vent Connectors.

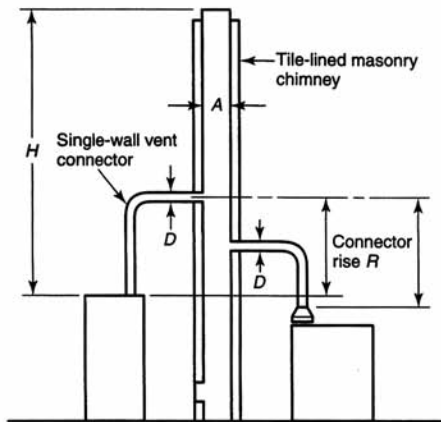
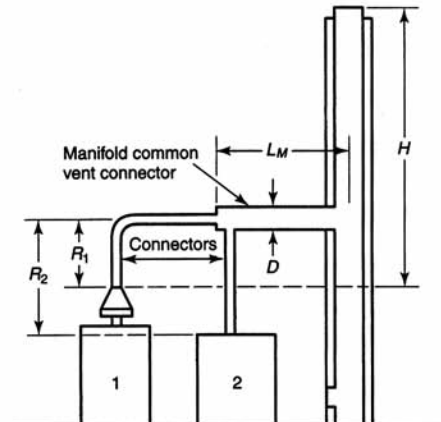


Table 5-17 is used when sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.

Notes:

1. A is the equivalent cross-sectional area of the tile liner.
2. Each appliance can be either Category I draft-hood-equipped or fan-assisted type.

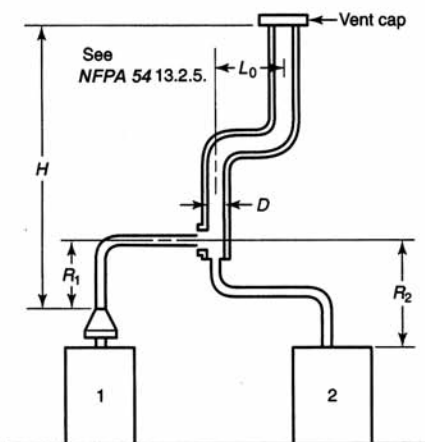
FIGURE G.1(i) Masonry Chimney Serving Two or More Appliances with Single-Wall Metal Vent Connectors.



Example: Manifolded common vent connector L_M can be no greater than 18 times the common vent connector manifold inside diameter; that is, a 4 in. (100 mm) inside diameter common vent connector manifold should not exceed 72 in. (1800 mm) in length.

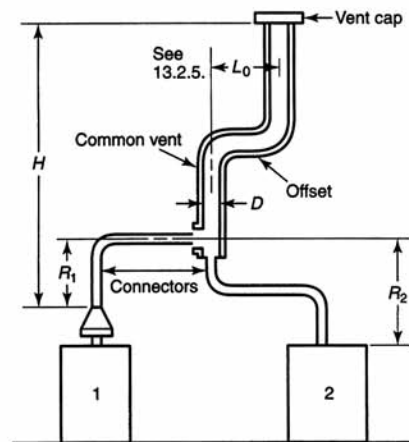
Note: This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible.

FIGURE G.1(k) Use of Manifolded Common Vent Connector.



Asbestos cement Type B or single-wall metal pipe vent serving two or more draft-hood-equipped appliances. (See Table 5-18)

FIGURE G.1(j) Asbestos Cement Type B or Single-Wall Metal Vent System Serving Two or More Draft-Hood-Equipped Appliances.



Example: Offset common vent

Note: This is an illustration of a typical offset vent. Different appliance, vent connector, or vent types are possible.

FIGURE G.1(l) Use of Offset Common Vent.

G.1.1 Example 1: Single Draft-Hood-Equipped Appliance. An installer has a 120,000-Btu/h 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 (1) a 5-foot lateral single-wall metal vent connector is used with two 90-degree elbows or (2) a 5-foot lateral single-wall metal vent connector is used with three 90-degree elbows in the vent system? See Figure G.1.1.

Solution

Table 5-9 should be used to solve this problem because single-wall metal vent connectors are being used with a Type B vent, as follows:

- (1) Read down the first column in Table 5-9 until the row associated with a 10-foot height and 5-foot lateral is found. Read across this row until a vent capacity greater than 120,000 Btu/h is located in the shaded columns labeled NAT Max for draft-hood-equipped appliances. In this case, a 5-inch-diameter vent has a capacity of 122,000 Btu/h and can be used for this application.
- (2) If three 90-degree elbows are used in the vent system, the maximum vent capacity listed in the tables must be reduced by 10 percent (see NFPA 54:13.1.3). This implies that the 5-inch-diameter vent has an adjusted capacity of only 110,000

Btu/h. In this case, the vent system must be increased to 6 inches in diameter. See the following calculations:

$$122,000 \times 0.90 = 110,000 \text{ for 5-inch vent}$$

From Table 5-10, select 6-inch vent.

$$186,000 \times 0.90 = 167,000$$

This figure is greater than the required 120,000. Therefore, use a 6-inch vent and connector where three elbows are used.

G.1.2. Example 2: Single Fan-Assisted Appliance. An installer has an 80,000 Btu/h 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 -degree elbows are needed for the installation. Can a single-wall metal vent connector be used for this application? See Figure G.1.2.

Solution

Table 5-10 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

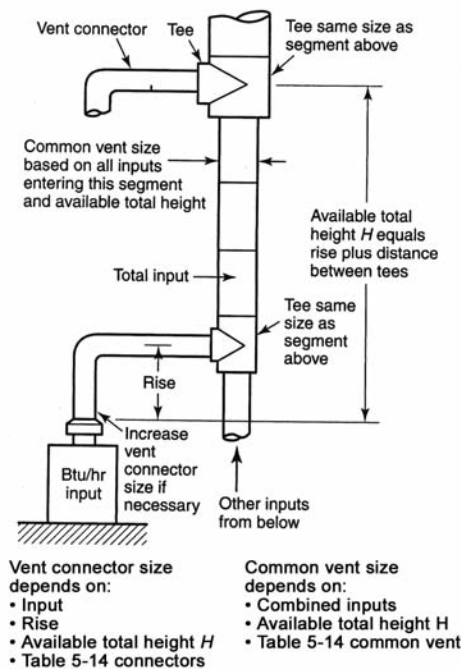


FIGURE G.1(m) Multistory Gas Vent Design Procedure for Each Segment of System.

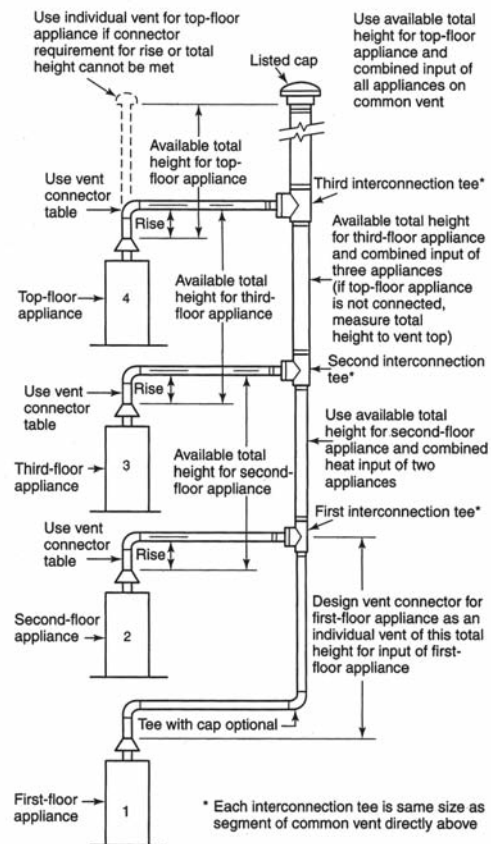


FIGURE G.1(n) Principles of Design of Multistory Vents Using Vent Connector and Common Vent Design Tables.

FAN Min and FAN Max columns, to find that a 3-inch diameter single-wall metal vent connector is not recommended. Moving to the next larger size single-wall connector (4 inch), we find that a 4-inch diameter single-wall metal connector has a recommended maximum vent capacity of 144,000 Btu/h. The 80,000 Btu/h fan-assisted appliance is outside this range, so the conclusion is that a single-wall metal connector could be used to vent the appliance. Table 5-9 shows the acceptable range of vent capacities for a 4 inch vent with 5 feet of lateral to be between 72,000 Btu/h and 157,000 Btu/h.

If the appliance cannot be moved closer to the vertical vent, then a Type B vent could be used as the connector material. In this case, Table 5-8 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 is between 37,000 Btu/h and 150,000 Btu/h.

G.1.3. Example 3: Interpolating Between Table Values. An installer has an 80,000 Btu/h input appliance with a 4-inch diameter draft hood outlet that needs to be vented into a 12-foot-high Type B. Can this appliance be vented using a 4-inch diameter vent?

Solution

Table 5-8 is used in the case of an all Type B Vent system. However, since there is no entry in Table 5-8 for a height of 12 feet, interpolation must be used. Read down the 4-inch diameter NAT Max column to the row associated with a 10-foot height and 5-foot lateral to find the capacity value of 77,000 Btu/h. Read further down to the 15-foot height, 5-foot lateral row to find the capacity value of 87,000 Btu/h. The difference between the 15-foot height capacity value and the 10-foot height capacity value is 10,000 Btu/h. The capacity for a vent system with a 12-foot height is equal to the capacity for a 10-foot height plus 2/5 of the difference between the 10-foot and 15-foot height values, or $77,000 + \frac{2}{5} \times 10,000 = 81,000$ Btu/h. Therefore, a 4-inch diameter vent can be used in the installation.

G.2 Examples Using Common Venting Tables.

G.2.1 Example 4: Common Venting Two Draft-Hood-Equipped Appliances. A 35,000-Btu/h water heater is to be common vented with a 150,000 Btu/h furnace, using a common vent with a total height of 30 feet. The connector rise is 2 feet for the water heater with a horizontal length of 4 feet. The connector rise for the furnace is 3 feet with a horizontal length of 8 feet. Assume single-wall metal connectors will be used with Type B vent. What size connectors and combined vent should be used in this installation?

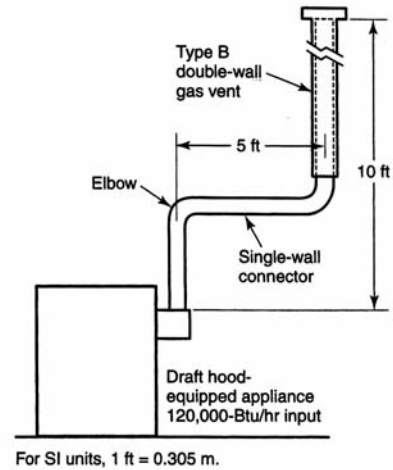


FIGURE G.1.1 Single Draft Hood-Equipped Appliance — Example 1.

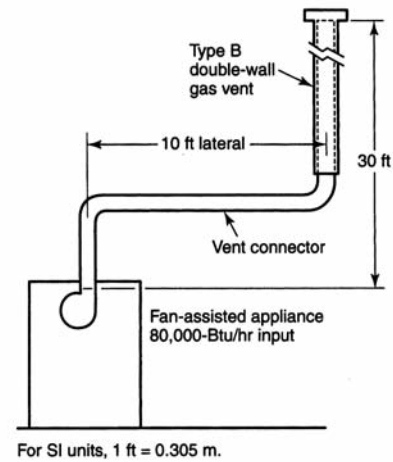


FIGURE G.1.2 Single Fan-Assisted Appliance — Example 2.

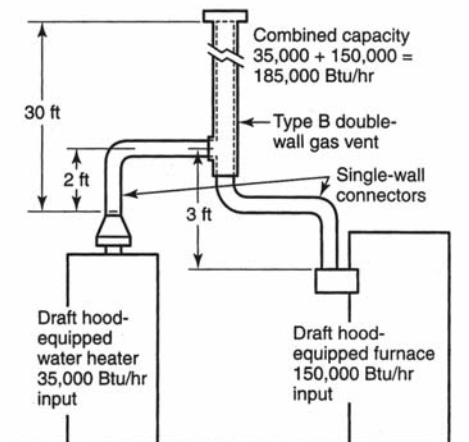


FIGURE G.2.1 Common Venting Two Draft Hood-Equipped Appliances — Example 4.

See Figure G.2.1.

Solution

Table 5-15 should be used to size single-wall metal vent connectors attached to Type B vertical vents. In the Vent Connector Capacity portion of Table 5-15, 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/h. Therefore, a 3-inch single-wall metal vent connector can 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/h (which is too small for the furnace), and a 6-inch diameter vent connector has a maximum vent capacity of 172,000 Btu/h. Therefore, a 6-inch diameter vent connector should be used with the 150,000 Btu/h furnace. Since both vent connector horizontal lengths are less than the maximum lengths listed in Table 5-8, the table values can be used without adjustments.

In the Common Vent Capacity portion of Table 5-15, find the row associated with a 30-foot vent height and read over to the NAT + NAT portion of the 6-inch diameter column to find a maximum combined capacity of 257,000 Btu/h. Since the two appliances total only 185,000 Btu/h, a 6-inch common vent can be used.

G.2.2 Example 5 (a): Common Venting a Draft-Hood-Equipped Water Heater with a Fan-Assisted Furnace into a Type B Vent. In this case, a 35,000-Btu/h input draft-hood-equipped water heater with a 4-inch diameter draft hood outlet, 2-feet of connector rise, and 4-feet of horizontal length is to be common vented with a 100,000 Btu/h fan-assisted furnace with a 4-inch diameter flue collar, 3-feet of connector rise, and 6-feet of horizontal length. The common vent consists of a 30-foot height of Type B vent. What are the recommended vent diameters for each connector and the common vent? The installer would like to use a single-wall metal vent connector. See Figure G.2.2.

Solution (See Table 5-15)

Water Heater Vent Connector Diameter. Since the water heater vent connector horizontal length of 4 feet is less than the maximum value listed in Table 5-15, the venting table values can be used without adjustment. Using the Vent Connector Capacity portion of Table 5-15, read down the Total Vent Height (*H*) column to 30 feet and read across the 2-foot Connector Rise (*R*) row to the first Btu/h rating

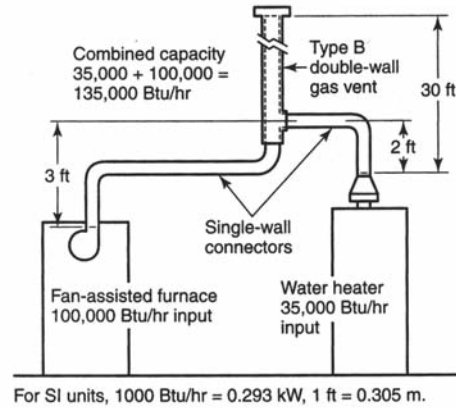


FIGURE G.2.2 Common Venting a Draft Hood-Equipped Water Heater with a Fan-Assisted Furnace into a Type B Double-Wall Common Vent — Example 5(a).

TABLE G.2.3 Masonry Chimney Liner Dimensions with Circular Equivalents

Nominal Liner Size (in.)	Inside Dimensions of Liner (in.)	Inside Diameter or Equivalent Diameter (in.)	Equivalent Area (in. ²)
4 x 8	2-1/2 x 6-1/2	4.0	12.2
		5.0	19.6
		6.0	28.3
		7.0	38.3
		7.4	42.7
8 x 8	6-3/4 x 6-3/4	8.0	50.3
		9.0	63.6
8 x 12	6-1/2 x 10-1/2	10.0	78.5
		10.4	83.3
		11.0	95.0
12 x 12	9-3/4 x 9-3/4	11.8	107.5
		12.0	113.0
12 x 16	9-1/2 x 13-1/2	14.0	153.9
		14.5	162.9
16 x 16	13-1/4 x 13-1/4	15.0	176.7
		16.2	206.1
16 x 20	13 x 17	18.0	254.4
		18.2	260.2
20 x 20	16-1/2 x 16-3/4	20.0	314.1
		20.1	314.2
20 x 24	16-1/2 x 20-1/2	22.0	308.1
		22.1	308.1
24 x 24	20-1/4 x 20-1/4	24.0	452.3
		24.1	456.2
24 x 28	20-1/4 x 24-1/4	26.4	543.3
		27.0	572.5
28 x 28	24-1/4 x 24-1/4	27.9	607.0
		30.9	749.9
30 x 30	25-1/2 x 25-1/2	33.0	855.3
		34.4	929.4
30 x 36	25-1/2 x 31-1/2	36.0	1017.9

For SI units, 1 in. = 25.4 mm, 1 in.² = 645 mm².

Note: When liner sizes differ dimensionally from those shown in this table, equivalent diameters can be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

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/h. Although this rating is greater than the water heater input rating, a 3-inch vent connector is prohibited by Section 511.2.18. A 4-inch vent connector has a maximum input rating of 67,000 Btu/h and is equal to the draft hood outlet diameter. A 4-inch vent connector is selected. Since the water heater is equipped with a draft hood, there are no minimum input rating restrictions.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table 5-15, read down the Total Vent Height (*H*) column to 30 feet and across the 3-foot Connector Rise (*R*) row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4-inch vent connector has a maximum input rating of 119,000 Btu/h and a minimum input rating of 85,000 Btu/h.

The 100,000-Btu/h furnace in this example falls within this range, so a 4-inch connector is adequate. Since the furnace vent connector horizontal length of 6 feet is less than the maximum value listed in Table 5-8, the venting table values can be used without adjustment. If the furnace had an input rating of 80,000 Btu/h, then a Type B vent connector would be needed in order to meet the minimum capacity limit. (see Table 5-14)

Common Vent Diameter. The total input to the common vent is 135,000 Btu/h. Using the Common Vent Capacity portion of Table 5-15, read down the Vent Height (*H*) column to 30 feet and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating equal to or greater than 135,000 Btu/h. The 4-inch common vent has a capacity of 132,000 Btu/h and the 5-inch common vent has a capacity of 202,000 Btu/h. Therefore, the 5-inch common vent should be used in this example.

Summary: In this example, the installer can use a 4-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 a 5-inch-diameter Type B vent.

G.2.3 Example 5 (b): Common Venting into an Interior Masonry Chimney. In this case, the water heater and fan-assisted furnace of Example 5 (a) are to be common-vented into a clay-tile-lined masonry chimney with a 30-foot height. The chimney is not exposed to the outdoors below the roof line. The internal dimensions of the clay tile liner are nominally 8 inches x 12 inches. Assuming the same vent connector heights, laterals, and materials found

in example 5 (a), what are the recommended vent connector diameters, and is this an acceptable installation?

Solution

Table 5-17 is used to size common venting installations involving single-wall connectors into masonry chimneys.

Water Heater Vent Connector Diameter. Using Table 5-17, Vent Connector Capacity, read down the Vent Height (*H*) column to 30 feet, and read across the 2-foot Connector Rise (*R*) row to the first Btu/h 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 of only 31,000 Btu/h, while a 4-inch vent connector has a maximum input of 57,000 Btu/h. A 4-inch vent connector must therefore be used.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table 5-17, read down the total Vent Height (*H*) column to 30 feet and across the 3-foot Connector Rise (*R*) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4-inch vent connector has a maximum input rating of 127,000 Btu/h and a minimum input rating of 95,000 Btu/h. The 100,000 Btu/h furnace in this example falls within this range, so a 4-inch connector is adequate.

Masonry Chimney. From Table G.2.3, the equivalent area for a nominal liner size of 8 inches x 12 inches is 63.6 inches². Using Table 5-17, Common Vent Capacity, read down the FAN + NAT column under the Minimum Internal Area of Chimney value of 63 to the row for 30-foot height to find a capacity value of 739,000 Btu/h. The combined input rating of the furnace and water heater, 135,000 Btu/h, is less than the table value so this is an acceptable installation.

Section 511.2.4 requires the common vent area to be no greater than seven times the smallest listed appliance categorized vent area, flue collar area, or draft hood outlet area. Both appliances in this installation have 4-inch-diameter outlets. From Table G.2.3, the equivalent area for an inside diameter of 4-inch is 12.2 in.². Seven times 12.2 equals 85.4, which is greater than 63.6, so this configuration is acceptable.

G.2.4 Example 5 (c): Common Venting into an Exterior Masonry Chimney. In this case, the water heater and fan-assisted furnace of Examples 5(a) and 5(b) are to be common-vented into an exterior masonry chimney. The chimney height, clay-tile-liner dimensions, and vent connector heights and laterals are the same as in Example 5(b). This system is being installed in Charlotte, North Carolina. Does this exterior masonry chimney need to be relined? If

so, what corrugated metallic liner size is recommended? What vent connector diameters are recommended? See Table G.2.3 and Figure 5-14.

Solution

According to 13.2.18, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table 5-21(a) and Table 5-21(b) to size FAN+NAT common venting installations involving Type-B double-wall connectors into exterior masonry chimneys.

The local 99 percent winter design temperature needed to use Table 5-21(a) and Table 5-21(b) can be found in the *ASHRAE Handbook – Fundamentals*. For Charlotte, North Carolina, this design temperature is 19°F.

Chimney Liner Requirement. As in Example 5 (b), use the 63 in.² column of Table 5-21(a) to the 30 ft height row to find that the combined appliance maximum input is 747,000 Btu/h. The combined input rating of the appliance in this installation, 135,000 Btu/h, is less than the maximum value, so this criterion is satisfied. Table 5-21(b), at a 19°F design temperature, and at the same vent height and internal area used earlier, shows that the minimum allowable input rating of a space-heating appliance is 470,000 Btu/h. The furnace input rating of 100,000 Btu/h is less than this minimum value. So this criterion is not satisfied, and an alternative venting design needs to be used, such as a Type B vent shown in Example 5(a) or a listed chimney liner system shown in the rest of the example.

According to Section 511.1.6, Table 5-9 or Table 5-10 are used for sizing corrugated metallic liners in masonry chimneys, with the maximum common vent capacities reduced by 20 percent. This example will be continued assuming Type B vent connectors.

Water Heater Vent Connector Diameter. Using Table 5-14 Connector Capacity, read down the total Vent Height (*H*) column to 30 feet, and read across the 2-foot Connector Rise (*R*) row to the first Btu/hour rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3 in. vent connector has a maximum capacity of 39,000 Btu/h. Although this rating is greater than the water heater input rating, a 3-inch vent connector is prohibited by 511.1.6. A 4 in. vent connector has a maximum input rating of 70,000 Btu/h and is equal to the draft hood outlet diameter. A 4-inch vent connector is selected.

Furnace Vent Connector Diameter. Using Table 5-14, Vent Connector Capacity, read down the total Vent Height (*H*) column to 30 feet, and read across the 3-foot Connector Rise (*R*) row to the first Btu/h rating in the FAN MAX column that is equal to or greater than the furnace input rating. The 100,000 Btu/h furnace in this example falls within this range, so a 4-inch connector is adequate.

Chimney Liner Diameter. The total input to the common vent is 135,000 Btu/h. Using the Common Vent Capacity portion of Table 5-14, read down the total Vent Height (*H*) column to 30 feet and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating greater than 135,000 Btu/h. The 4 in. common vent has a capacity of 138,000 Btu/h. Reducing the maximum capacity by 20 percent (see 13.2.19) results in a maximum capacity for a 4-inch corrugated liner of 110,000 Btu/h, less than the total input of 135,000 Btu/h. So a larger liner is needed. The 5-inch common vent capacity listed in Table 5-14 is 210,000 Btu/h, and after reducing by 20 percent is 168,000 Btu/h. Therefore, a 5-inch corrugated metal liner should be used in this example.

Single Wall Connectors. Once it has been established that relining the chimney is necessary, Type B double-wall vent connectors are not specifically required. This example could be redone using Table 5-15 for single-wall vent connectors. For this case, the vent connector and liner diameters would be the same as found for Type B double-wall connectors.

The following is originally from NFPA 54, which contains additional reference.

Example of Combination of Indoor and Outdoor Combustion and Ventilation Opening Design.

J.1 Example of Combination Indoor and Outdoor Combustion Air Opening. Determine the required combination of indoor and outdoor combustion air opening sizes for the following equipment installation example.

Example Installation: A fan-assisted furnace and a draft-hood-equipped water heater with the following inputs are located in a 15-foot x 30-foot basement with an 8-foot ceiling. No additional indoor spaces can be used to help meet the equipment combustion air needs.

Fan-Assisted Furnace Input: 100,000 Btu/h
Draft-Hood-Equipped Water Heater Input:
40,000 Btu/h

Solution

- (1) Determine the total available room volume:
Equipment room volume: 15 feet x 30 feet with an 8-foot ceiling = 3,600 feet³
- (2) Determine the total required volume: The standard method to determine combustion air will be used to calculate the required volume.
The combined input for the appliances located in

the basement is calculated as follows:

100,000 Btu/h + 40,000 Btu/h = 140,000 Btu/h
 The Standard Method requires that the required volume be determined based on 50 cubic feet per 1,000 Btu/hour. Using Table A.9.3.2.1, the required volume for a 140,000 Btu/h water heater is 7,000 feet³.

Conclusion: Indoor volume is insufficient to supply combustion air since the total of 3,600 feet³ does not meet the required volume of 7000 feet³. Therefore, additional combustion air must be provided from the outdoors.

- (3) Determine ratio of the available volume to the required volume:
 $3,600 \text{ ft.}^3 = 0.51$
 7000 ft.^3
- (4) Determine the reduction factor to be used to reduce the full outdoor air opening size to the minimum required based on ratio of indoor spaces:
 $1.00 - 0.51$ (from Step 3) = 0.49
- (5) Determine the single outdoor combustion air opening size as if all combustion air is to come from outdoors. In this example, the combustion air opening directly communicates with the outdoors.
 $140,000 \text{ Btu/h} = 47 \text{ in.}^2$
 $3,000 \text{ Btu/in.}^2$
- (6) Determine the minimum outdoor combustion air opening area:
 Outdoor opening area = 0.49
 (from Step 4) $\times 47 \text{ in.}^2 = 23 \text{ in.}^2$

Section 507.3 requires the minimum dimension of the air opening should not be less than 3 inches.

TABLE A.9.3.2.1
Standard Method Volume, All Appliances

Appliance Input (Btu/h)	Required Volume (ft. ³)
5,000	250
10,000	500
15,000	750
20,000	1,000
25,000	1,250
30,000	1,500
35,000	1,750
40,000	2,000
45,000	2,250
50,000	2,500
55,000	2,750
60,000	3,000
65,000	3,250
70,000	3,500
75,000	3,750
80,000	4,000
85,000	4,250
90,000	4,500
95,000	4,750
100,000	5,000
105,000	5,250
110,000	5,500
115,000	5,750
120,000	6,000
125,000	6,250
130,000	6,500
135,000	6,750
140,000	7,000
145,000	7,250
150,000	7,500
160,000	8,000
170,000	8,500
180,000	9,000
190,000	9,500
200,000	10,000
210,000	10,500
220,000	11,000
230,000	11,500
240,000	12,000
250,000	12,500
260,000	13,000
270,000	13,500
280,000	14,000
290,000	14,500
300,000	15,000

507.4.1 See Figure 5-8 • 507.4.1(1) See Figure 5-9 and Figure 5-10 • 507.4.1(2) See Figure 5-11 • 507.4.2 See Figure 5-12 • For information on gas convenience outlets, see AGA 7-90, *Requirements for Gas Convenience Outlets*.

WATER HEATERS