

# CHAPTER 7

## COMBUSTION AIR

### 701.0 Air for Combustion and Ventilation.

#### 701.1 General.

**701.1.1** 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 701.2 through 701.8.3. 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 701.4 through 701.8.3.

#### Exceptions:

- (1) This provision shall not apply to direct-vent appliances.
- (2) Type 1 clothes dryers that are provided with makeup air in accordance with Section 504.3.2.

**701.1.2** 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]

**701.1.3** 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]

**701.1.4** 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]

**701.2 Indoor Combustion Air.** The required volume of indoor air shall be determined in accordance with the method in section 701.2.1 or 701.2.1.1, except that where the air infiltration rate is known to be less than 0.40 ACH, the method in Section 701.2.1.1 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 701.3.1, are considered a part of the required volume. [NFPA 54: 9.3.2]

**701.2.1 Standard Method.** The minimum required volume shall be fifty (50) cubic feet per 1,000 Btu/hour (4.8 m<sup>3</sup>/kW) [NFPA 54: 9.3.2.1].

#### 701.2.1.1 Known Air Infiltration Rate Method Equations.

##### Equation 701.2.1.1(a):

Required Volume<sub>other</sub> ≥ (21 ft.<sup>3</sup> / ACH) x (I<sub>other</sub>/1,000 Btu/hr)

##### Equation 701.2.1.1(b):

Required Volume<sub>fan</sub> ≥ (15 ft.<sup>3</sup> / ACH) x (I<sub>fan</sub>/1,000 Btu/h.)

WHERE:

I<sub>other</sub> = all appliances other than fan-assisted input in Btu per hour

I<sub>fan</sub> = fan-assisted appliance input in Btu per hour

ACH = air change per hour (percent of volume of space exchanged per hour, expressed as a decimal)

#### 701.2.2 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 701.2.1.1(a) but no smaller than thirty-five (35) cubic feet per 1,000 Btu/hour (3.4 m<sup>3</sup>/kW). [NFPA 54: 9.3.2.2(1)]
- (2) For fan-assisted combustion system appliances: calculate using equation 701.2.1.1(b) but no smaller than twenty-five (25) cubic feet per 1000 Btu/hour (2.4 m<sup>3</sup>/kW). [NFPA 54: 9.3.2.2(2)]
- (3) For purposes of this calculation, an infiltration rate greater than 0.60 ACH shall not be used in the equations. [NFPA 54: 9.3.2.2(3)]

#### 701.3 Indoor Opening Size and Location.

**701.3.1** 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.<sup>2</sup>/1,000 Btu/h. (220 mm<sup>3</sup>/kW) of the total

input rating of all gas utilization equipment in the space, but not less than 100 in.<sup>2</sup> (0.06 m<sup>2</sup>). One opening shall commence within twelve (12) inches (300 mm) of the top, and one opening shall commence within twelve (12) in. (300 mm) of the bottom, of the enclosure. (See Figure 7-1.) The minimum dimension of air openings shall be not less than three (3) inches (80 mm). [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.<sup>2</sup>/1,000 Btu/h (4,400 mm<sup>2</sup>/kW) of total input rating of all gas utilization equipment. [NFPA 54:9.3.2.3(2)]

**701.4 Outdoor Combustion Air.** Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with the methods in Section 701.4.1 or 701.4.2. The minimum dimension of air openings shall not be less than three (3) inches (80 mm). [NFPA 54:9.3.3]

**701.4.1 Two Permanent Openings Method.**

Two permanent openings, one commencing within twelve (12) inches (300 mm) of the top and one commencing within twelve (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 [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.<sup>2</sup>/4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure. (See Figures 7-2 and 7-3.) [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.<sup>2</sup>/2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure. (See Figure 7-4.) [NFPA 54:9.3.3.1(2)]

**701.4.2 One Permanent Opening Method.** One permanent opening, commencing within twelve (12) inches (300 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least one (1) inch (25 mm) from the sides and back and six (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 7-5) and shall have a minimum free area of [NFPA 54: 9.3.3.2]:

- (1) 1 in.<sup>2</sup>/3,000 Btu/h (700 mm<sup>2</sup>/kW) of the total input rating of all equipment located in the enclosure, and
- (2) Not less than the sum of the areas of all vent connectors in the space. [NFPA 54:9.3.3.2]

**701.5 Combination Indoor and Outdoor Combustion Air.**

The use of a combination of indoor and outdoor combustion air shall be in accordance with Sections 701.5.1 through 701.5.3. [NFPA 54:9.3.4]

**701.5.1 Indoor Openings.** Where used, openings connecting the interior spaces shall comply with Section 701.3.1. [NFPA 54:9.3.4(1)]

**701.5.2 Outdoor opening(s)** shall be located in accordance with Section 701.4. [NFPA 54:9.3.4(2)]

**701.5.3 Outdoor Opening(s) Size.** The outdoor opening(s) 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. [NFPA 54:9.3.4(3)(a)]
- (2) The outdoor size reduction factor shall be 1 minus the ratio of interior spaces. [NFPA 54:9.3.4(3)(b)]
- (3) The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Section 701.4, multiplied by the reduction factor. The minimum dimension of air openings shall not be less than three (3) inches (80 mm). [NFPA 54:9.3.4(3)(c)]

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

**701.7 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 feet<sup>3</sup>/min per 1,000 Btu/h (0.034 m<sup>3</sup>/min per kW) for all appliances located within the space. [NFPA 54:9.3.6]

**701.8 Mechanical Combustion Air Requirements.**

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

**701.8.2** 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]

**701.8.3** 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]

### 701.9 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, grille or screen is known, it shall be used in calculating the size opening required to provide the free area specified. Where the louver and grille design and free area are not known, it shall be assumed that wood louvers will have a 25 percent free area and metal louvers and grilles will have a 75 percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. [NFPA 54:9.3.7.1]

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

**(C) Motorized Louvers.** 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 startup and to shut down the main burner if the louvers close during burner operation. [NFPA 54:9.3.7.3]

**701.10 Combustion Air Ducts.** Combustion air ducts shall comply with the following [NFPA 54:9.3.8]:

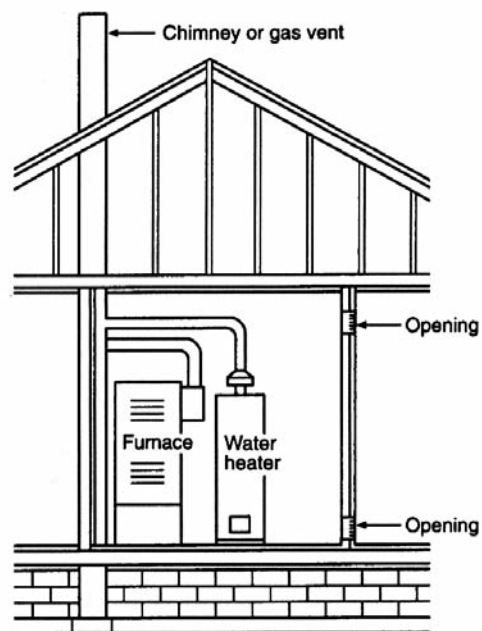
- (1) Ducts shall be of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity. [NFPA 54:9.3.8.1]

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

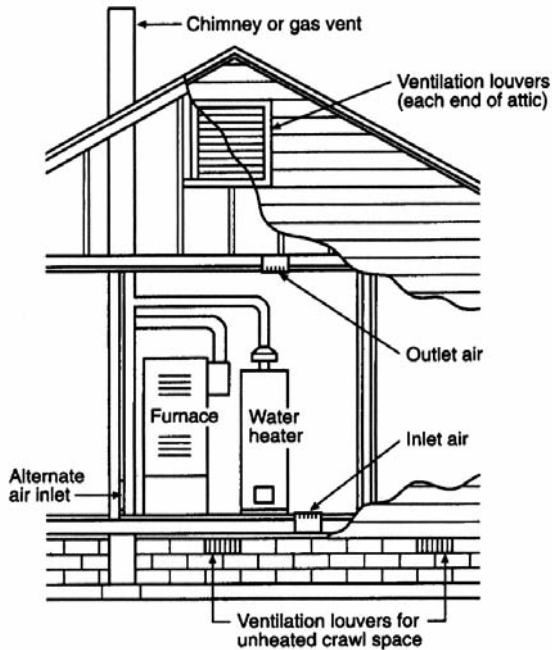
- (2) Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:9.3.8.2]
- (3) Ducts shall serve a single space. [NFPA 54:9.3.8.3]
- (4) Ducts shall not service both upper and lower combustion air openings where both such openings are used. The 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 terminating in attics shall not be screened. [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 twelve (12) inches vertically from the adjoining grade level. [NFPA 54:9.3.8.8]
- (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 unless it is listed and shown in the manufacturer's installation instructions. [NFPA 54:9.3.8.7]

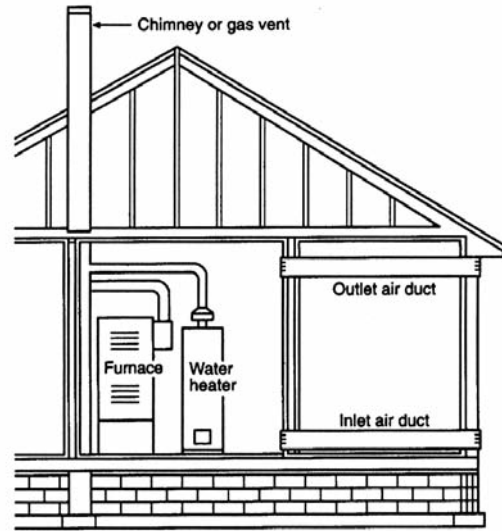
**701.11 Dampers Prohibited.** Combustion-air ducts or plenums shall not be installed so as to require openings in or penetrations through construction where fire dampers are required. Manually operated dampers shall not be installed in combustion-air openings. With prior approval, power-actuated movable louvers admitting combustion air may be used and, if installed, shall be electrically interlocked with the main burner fuel-supply valve so as to prevent fuel delivery unless the louvers are in the fully open position.



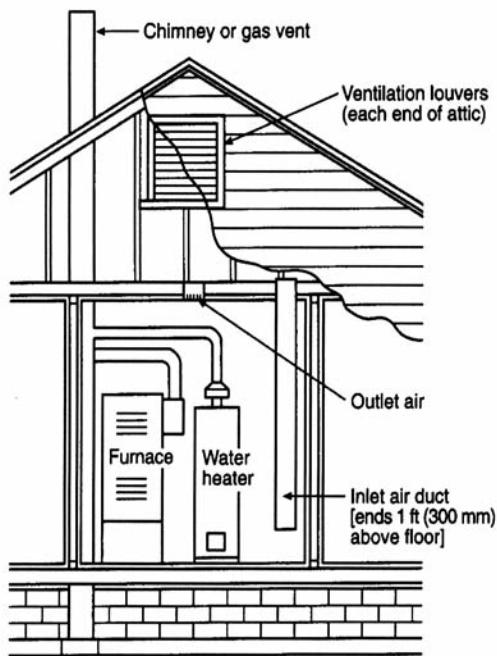
**FIGURE 7-1 All Combustion Air from Indoor Spaces Through Indoor Combustion Air Openings. [NFPA 54: A8.3.2.3(1)]**



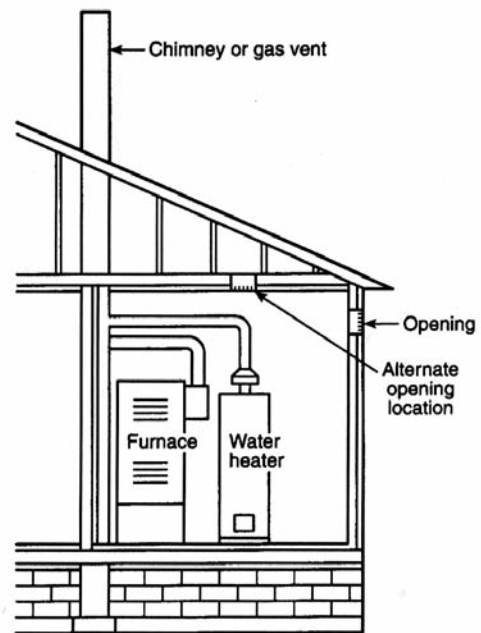
**FIGURE 7-2 All Combustion Air from Outdoors— Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic. [NFPA 54: A.8.3.3.(1) (A)]**



**FIGURE 7-4 All Combustion Air from Outdoors Through Horizontal Ducts. [NFPA 54: A.8.3.3.1(2)]**



**FIGURE 7-3 All Combustion Air from Outdoors Through Ventilated Attic. [NFPA 54: A.8.3.3.1(1)(b)]**



**FIGURE 7-5 All Combustion Air from Outdoors Through Single Combustion Air Opening. [NFPA 54:A.8.3.3.2]**