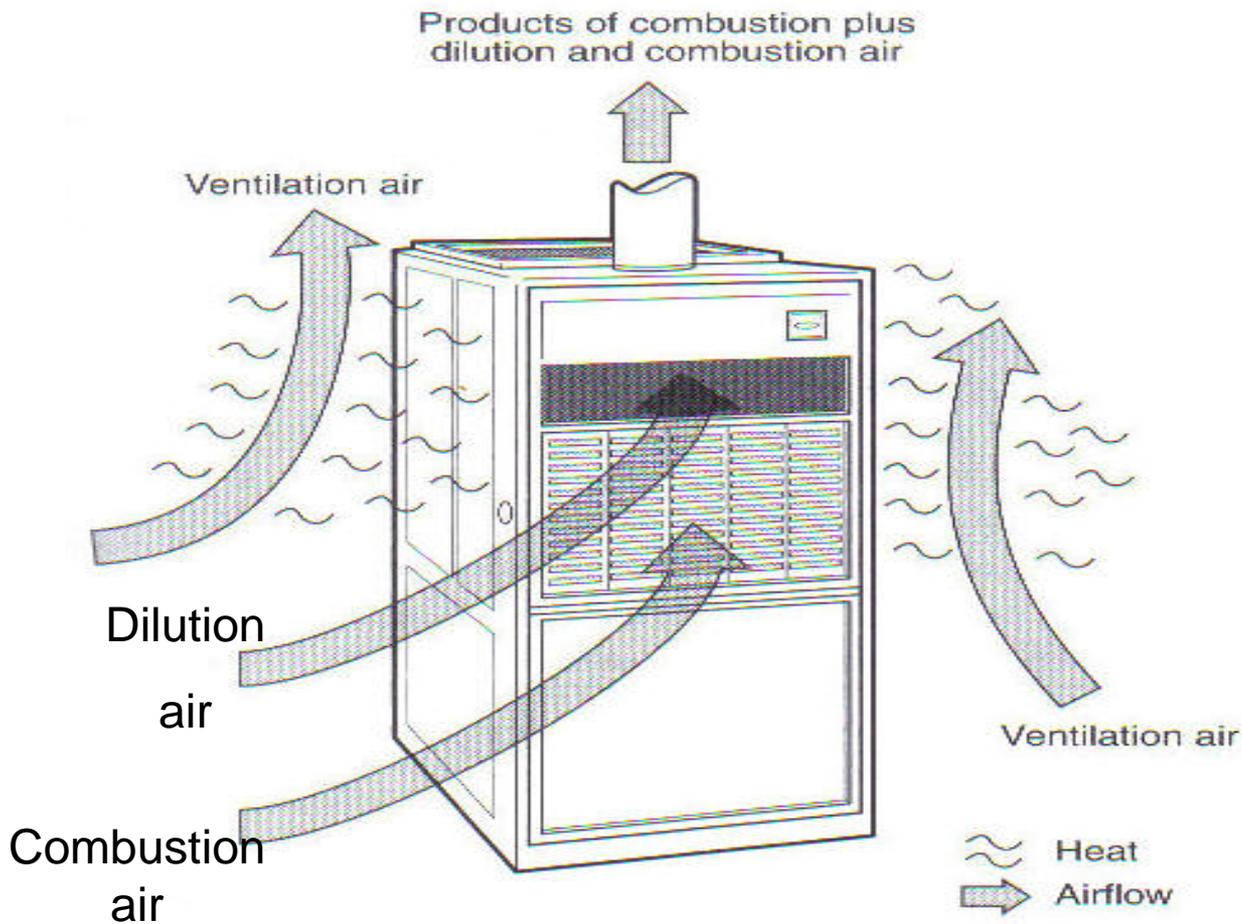


CHAPTER 4 COMBUSTION AIR

The importance of combustion, dilution, and
ventilation air

EXAMPLE OF COMBUSTION, DILUTION, AND VENTILATION AIR



NATURAL DRAFT GAS FURNACE

- For every cubic foot of gas burned in a natural gas furnace you need approximately 21 ft.³ of air.
- Some modern fan assisted combustion furnace systems do not need dilution air they still require approximately 15 ft.³ of air for each cubic foot of gas burned



HOW MUCH AIR IS THAT?

- The amount of air can range between 1500 ft.³ per hour and 2100 ft.³ per hour for each 100,000 BTU per hour of gas input
- This air is needed to support the combustion and offending process of the appliance and to provide ventilation cooling for the casing and the internal controls.



OPENINGS NECESSARY FOR SUPPLY AIR FOR COMBUSTION WHEN APPLIANCES INSTALLED IN A CONFINED AREA

Ventilating air outlet register for furnace room. 1 in.² (645 mm²) free area for each 1000 Btu/hr (0.3 kW) furnace input, located above relief opening of draft hood. Register must not be blocked by drapes or other furnishings.

Flue should terminate above peak of roof and above nearby walls to assure satisfactory flue performance. In installations where the flue terminal is below nearby walls or roof peaks, an effective vent cowl should be used.

Both registers must either face same large well-ventilated interior space or extend to such space by means of ducts. Vertical distance \bar{C} to \bar{C} of registers should be not less than 3.5 ft. (1.1 m).

Suggest room access door be not less than 6 ft (1.8 m) high by a width sufficient to provide for installation or removal of furnace. At least 2 ft (0.6 m) horizontal clearance should be provided in front of furnace when closet door is open or 18 in. (0.5 m) when door is closed.*

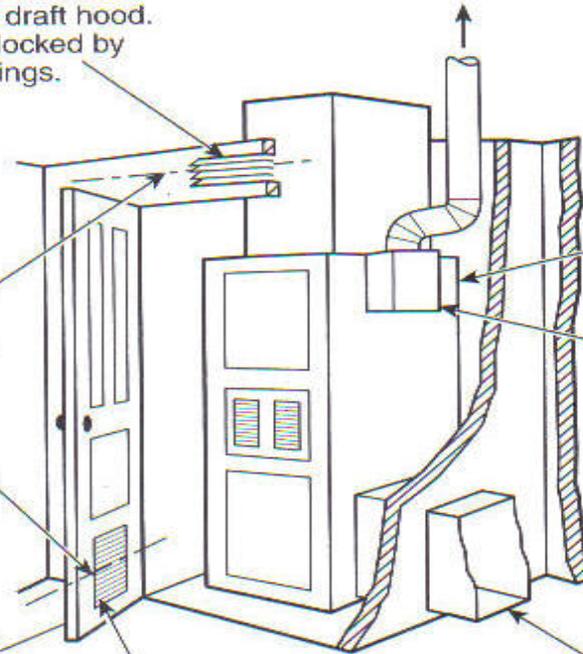
Combustion and ventilation air inlet register for furnace room. 1 in.² (645 mm²) free area for each 1000 Btu/hr (0.3 kW) furnace input, located at or below combustion air inlet to furnace. Register must not be blocked by drapes or other furnishings.

No part of furnace casing closer than 6 in. (0.2 m) to wall.*

Spacing between draft hood and wall at least 6 in. (150 mm). If flue products may be directed toward wall, 12 in. (0.3 m) spacing recommended.*

Air circulated by furnace must be handled by ducts, which are sealed to furnace casing and are entirely separate from means provided for supplying combustion and ventilation air.

*Unless approved for a closer spacing.



- This section on combustion air will show you the proper methods of meeting these requirements.



THE STANDARD METHOD

- This is the method we will be using.
- The standard method, which has been in the code since the 1950s, can be used for buildings that have a 0.40 air change per hour (ACH) or higher air infiltration rate.
- The minimum required volume shall be 50 ft.³ per 1000 BTUs per hour



THE HISTORY OF COMBUSTION AIR REQUIREMENTS

- The first gas safety standard was published in 1927.
- The requirement for air for combustion was very brief its stated: no appliance designed to burn gas at a rate greater than ordinary lighting burner shall be installed in a room which is not adequately ventilated.



FOLLOWING WORLD WAR II

- Gas for heating became very popular most of the housing was on a concrete slab so they put the furnaces in the closets so they didn't take up a lot of room.
- This was the beginning of many code changes.



THE MOST SIGNIFICANT CHANGE IN THE CODE WAS IN 1969

- This required that the opening be located within 12 inches of the top and 12 inches of the bottom of the enclosed room
- The use of two openings, high and low, to the outdoors still is present and practice today.



SPECIAL CONDITIONS CREATED BY MECHANICAL EXHAUSTING OR FIREPLACES

- Operation of exhaust fans, ventilation systems, clothes dryer's, or fireplaces can create conditions requiring special attention to avoid unsatisfactory operation of the installed gas appliances.



FIVE METHODS TO SUPPLY COMBUSTION AIR

- 100% indoor air
- 100% outdoor air
- Combination of indoor and outdoor air
- Engineered systems
- Mechanical air supply



MAKEUP AIR REQUIREMENTS

- Makeup air requirements for the operation of exhaust fans, kitchen ventilation systems, clothes dryers, and fireplaces shall be considered in determining the amount of space to provide combustion air requirements

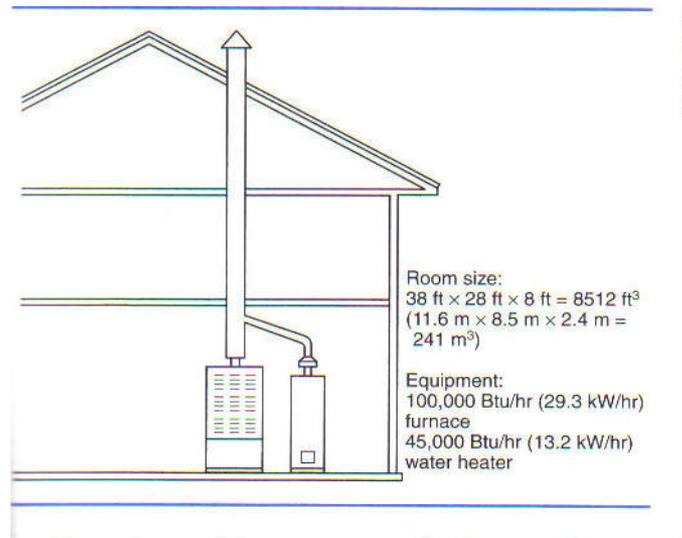


ROOM WITH FURNACE AND WATER HEATER

- This next slide shows a room in which a furnace and water heater are installed. We will look at the calculation worksheet which will show how to determine whether the space shown is confined or on confined space.



ROOM WITH FURNACE AND WATER HEATER



CALCULATION WORKSHEET: COMBUSTION AIR, STANDARD METHOD

Step 1:

- Calculate the room volume.

Room volume: Room length: 38 ft
 Room width: 28 ft
 Room height: 8 ft

Room volume: = Length × width × height
 = 8512 ft³

Step 2:

- Calculate the total input of all appliances in the room.
- Enter the input rating of all appliances in Table 1. (Per 9.3.1.1, Exception 2, dryers are not included.)
- Total the column.
- Divide the total by 1000 (of Btu/hr).

Table 1 Appliances Table

Appliance	Input rating (Btu/hr)
Furnace	100,000
Water heater	40,000
Space heater	
Range	
Other	
Total	140,000
Total/1000	140

Step 3:

- Calculate the required volume. Divide room volume (Step 1) by total/1000 (Step 2).
- If less than 50, additional air is needed.
- If greater than or equal to 50, no additional air is needed.

Required volume: = $\frac{8512 \text{ ft}^3}{140}$
 = 60.8

Additional air needed? (Check one) Yes No

ALTERNATE CALCULATION METHOD

Step 1:

- Calculate the room volume.

Room volume = 8512 ft³ (from Step 1 above)

Step 2:

- Calculate the maximum appliance input.

Maximum appliance input: = Room volume × 20
 = 8512 × 20
 = 170,240 Btu/hr

Step 3:

- Determine if additional air is needed.
- If less than max., no additional air is needed.
- If greater than or equal to max., additional air is needed.

Total appliance input: = 140,000 Btu/hr

Additional air needed? (Check one) Yes No

Job: 25 Main Street Prepared by: TL Date: 1/1/06

OUTDOOR COMBUSTION AIR

- Outdoor combustion air shall be provided through openings to the outdoors in accordance with the methods in 9.3.3.1 or 9.3.3.2. The minimum dimension of air openings shall not be less than 3 inches.



TWO PERMANENT OPENINGS METHOD

- Two permanent openings, one commencing within 12 inches of the top and one commencing within 12 inches of the bottom of the enclosed shall be provided
- Where openings are directly to the outdoors through vertical blocks each opening job a minimum of three area of 1 in.²/4000 Btu/hr of total into a rating of all and appliances in the enclosure
- Example on next slides



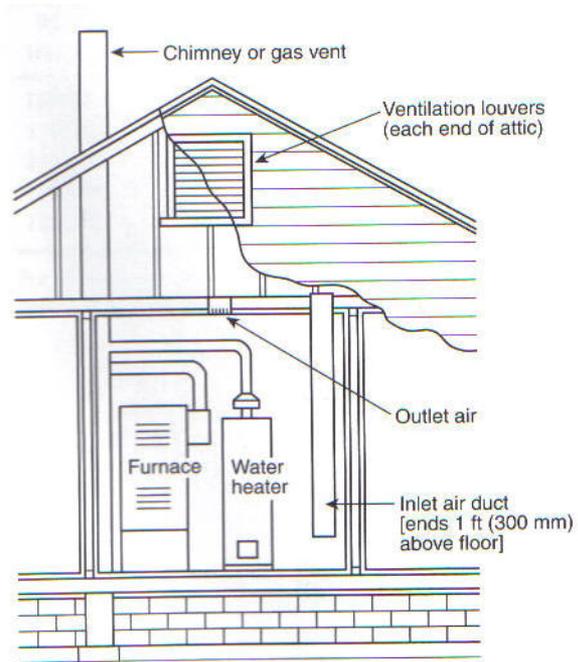


FIGURE A.9.3.3.1(1)(b) All Combustion Air from
Outdoors through Ventilated Attic.



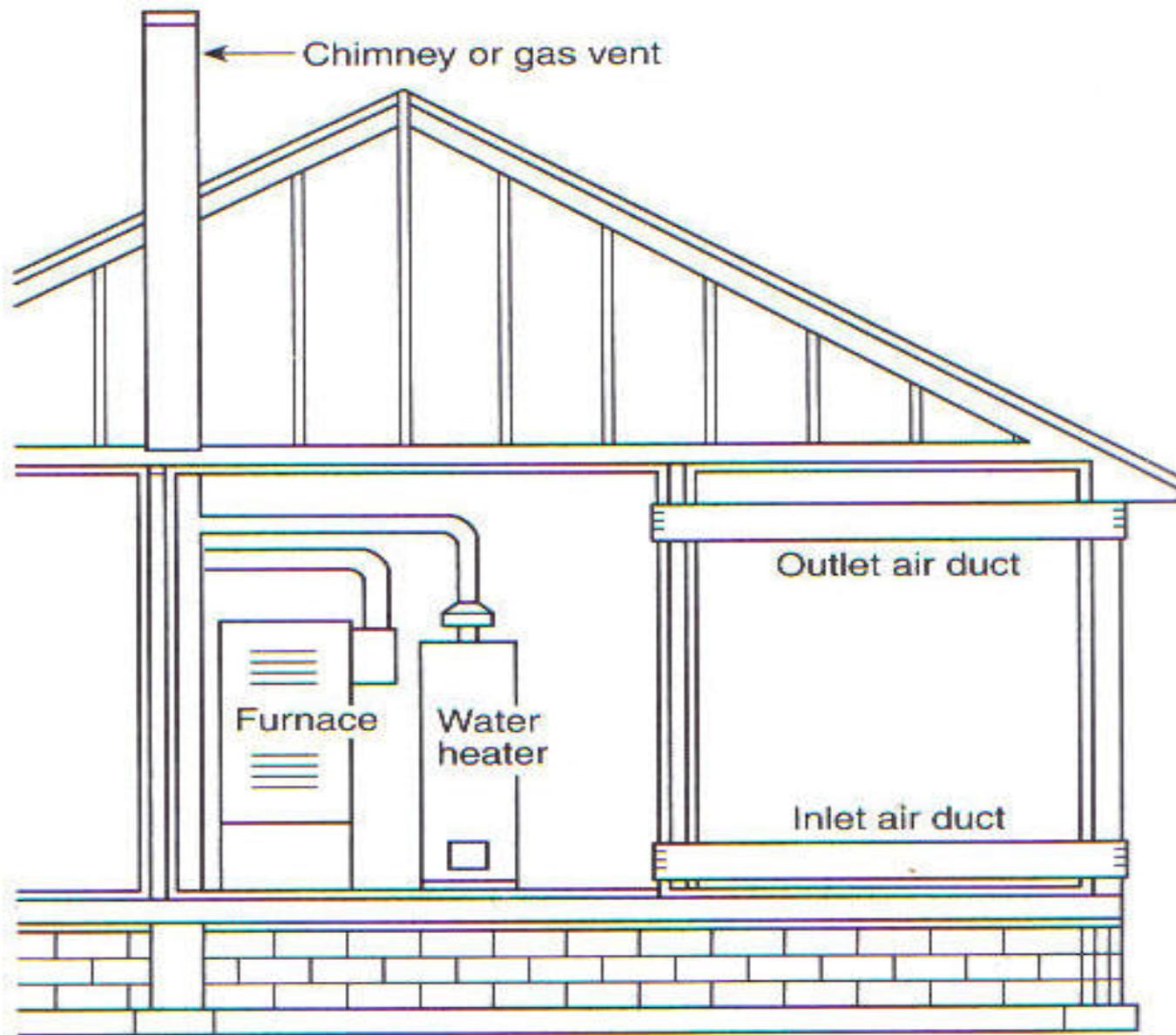
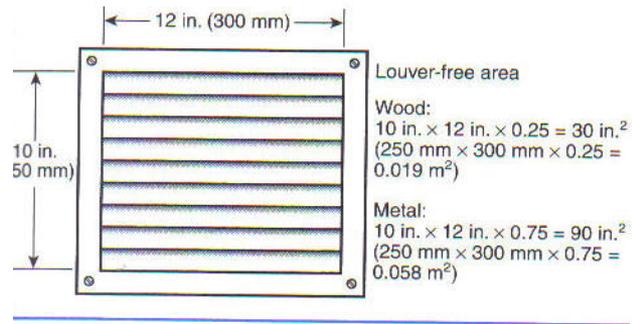


FIGURE A.9.3.3.1(2) *All Combustion Air from Outdoors through Horizontal Ducts.*



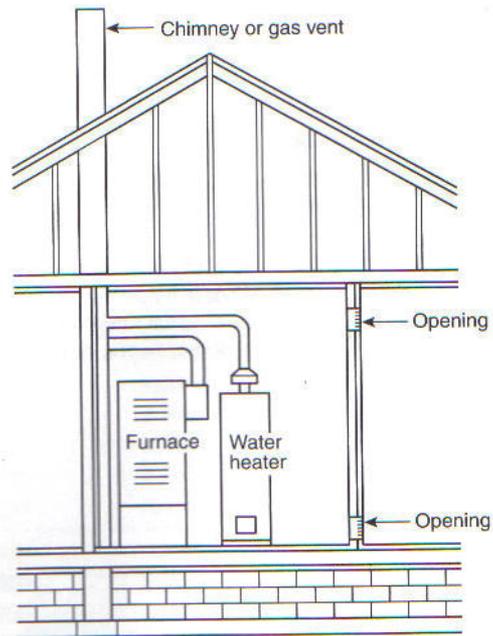


FIGURE A.9.3.2.3(1) All Combustion Air from Adjacent Indoor Spaces through Indoor Combustion Air Openings.



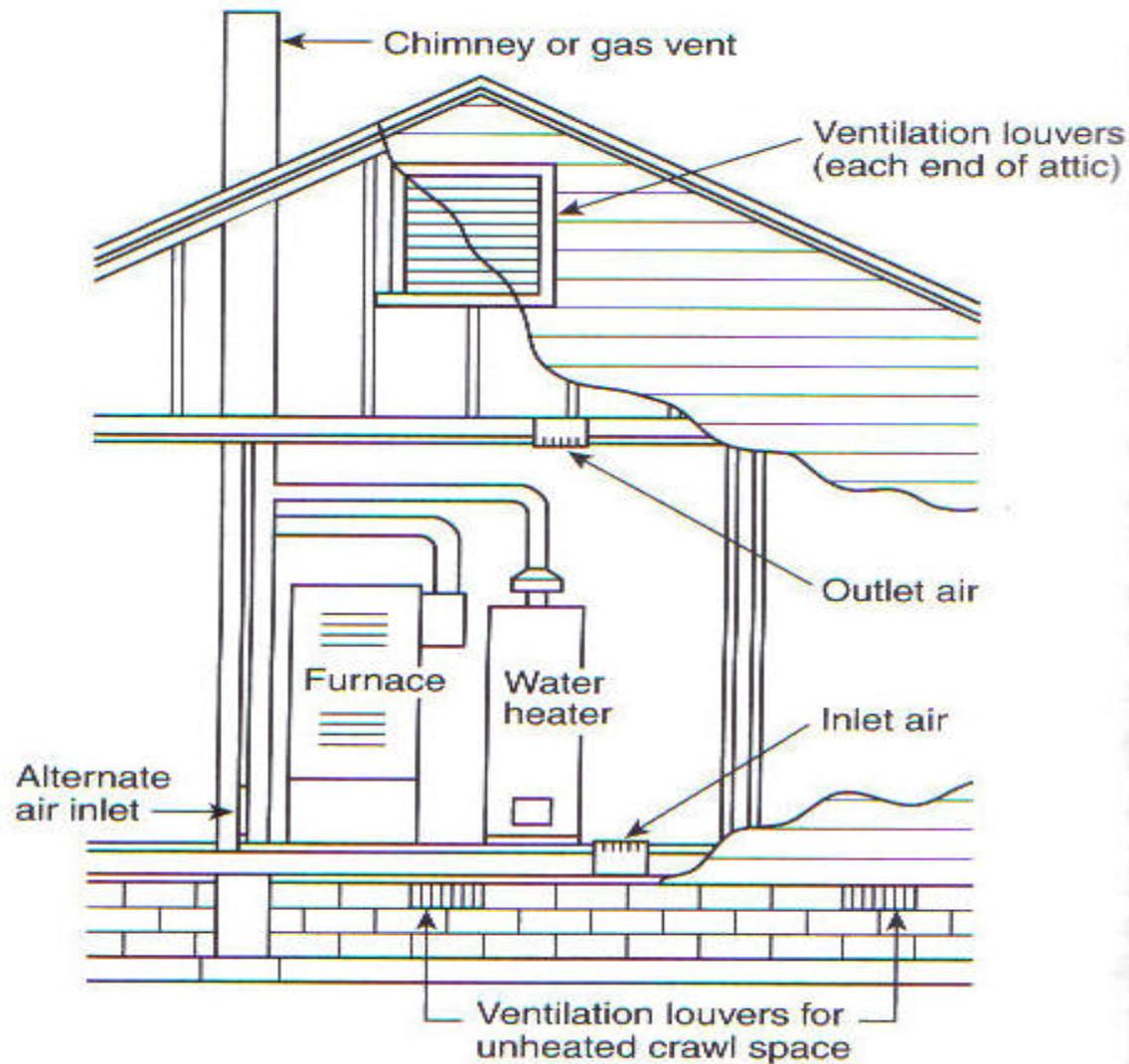


FIGURE A.9.3.3.1(1)(a) *All Combustion Air from Outdoors — Inlet Air from Ventilated Crawl Space and Outlet Air to Ventilated Attic.*



ONE PERMANENT OPENING METHOD

- One permanent opening, commencing within 12 inches of the top of the enclosure, shall be provided. The opening shall have the clearance of it least 1 inch from the sides and the back and 6 inches from the front of the appliance. The opening shall be directly to the outdoors and show the vertical or horizontal path to the outdoors or spaces that freely adjacent with the outdoors and shall have a minimum of three square feet of the following: 1 in 2/ 3000 BTUs /hr of the total into a reading of all appliances located in the enclosed area.



ONE PERMANENT OPENING METHOD

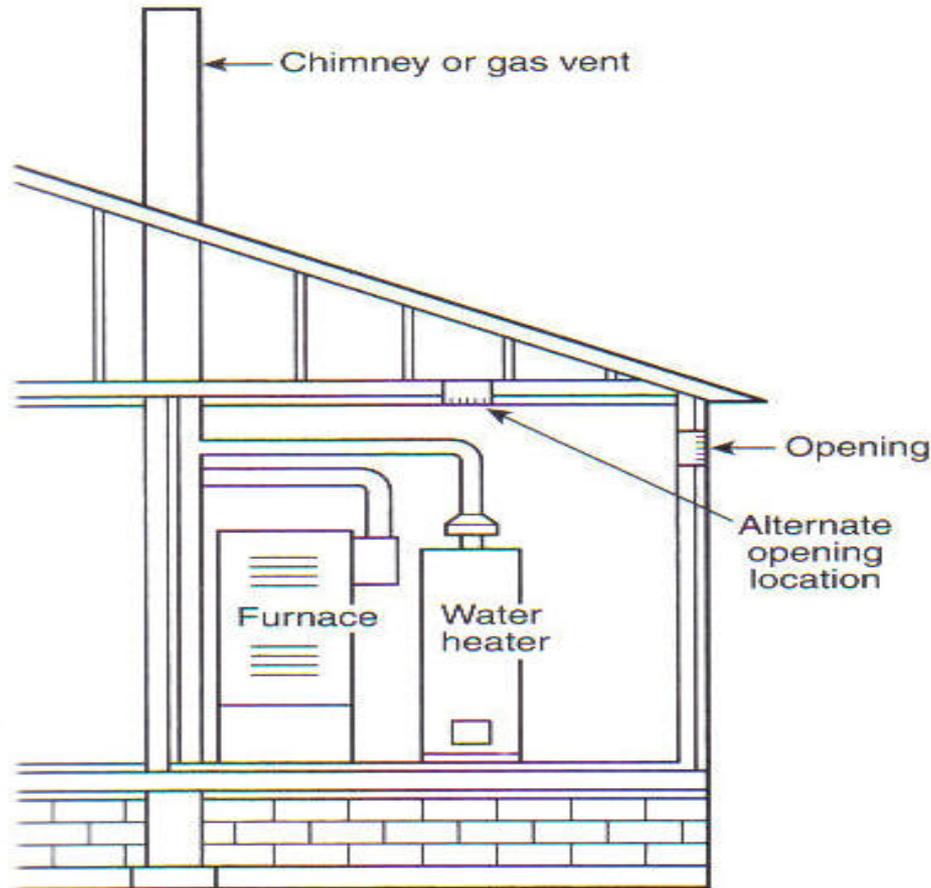


FIGURE A.9.3.3.2 All Combustion Air from Outdoors through Single Combustion Air Opening.



SIZING COMBUSTION AIR OPENINGS

- Where all combustion and ventilation air is taken from outdoors either directly by docs one or two method is permitted. The first method requires two openings or to docs either vertical or horizontal commencing within 12 inches of the ceiling and floor. The second method allows one opening.



- Ducts must be the same area as the opening to which they connect. Vertical ducts or openings are sized at a minimum degree area of 1 in.² per 4000 Btu/hr of the total appliance input installed in the space.
- The code requires horizontal ducts to have a minimum of three area of 1 in.² per 2000 Btu/hr of the total appliance input installed in the space



- These openings or ducts and connect to spaces that freely are accessible to the outdoors.
- Vertical ducts allow a convection effect to occur, where warmer air gravitates out of the upper duct opening while the lower ducts introduces cooler air this convection effect provides a higher ACH and vertical ducts and then in horizontal ducts, where this effect is less pronounced.



WORKSHEET FOR SIZING COMBUSTION AIR OPENINGS

CALCULATION WORKSHEET: SIZING COMBUSTION AIR OPENINGS

Step 1:

- Enter the input ratings of all appliances in Table 1.
- Total the column.
- Proceed to either Part A, Part B, or Part C.

Table 1 Ratings for Appliances

Appliance	Input rating (Btu/hr)
Furnace	100,000
Water heater	45,000
Space heater	
Total	145,000

A. All air from outdoors via two permanent openings (or vertical ducts).

Step 2:

- Where all air is to be taken from the outdoors, divide the total input of all gas appliances in the space by 4000.

Total input:

$$145,000 / 4000 = 36.25 \text{ in.}^2/\text{opening}$$

Step 3:

- Select a duct with the area needed.
- Use Table 2 to calculate for square or round ducts. For other sizes or rectangular shapes, the duct size can be calculated.

Table 2 Sizes for Square and Round Ducts

Area of square ducts		Area of round ducts	
Side (in.)	Area (in. ²)	Diameter (in.)	Area (in. ²)
3	9	3	7.1
4	16	4	12.6
5	25	5	19.6
6	36	6	28.3
7	49	7	38.5
8	64	8	50.2
10	100	10	78.5
12	144	12	113.0

Square duct: $6 \text{ in.} \times 6 \text{ in.} = 36 \text{ in.}^2$

Round duct: $7 \text{ in. round} = 38.5 \text{ in.}^2$

B. All air from the outdoors via two horizontal ducts.

Step 2:

- Where all air is to be taken from the outdoors, divide the total input of all gas appliances in the space by 2000.

Total input:

$$145,000 / 2000 = 73 \text{ in.}^2/\text{opening}$$

Step 3:

- Select a duct with the area needed.
- Use Table 2 to calculate for square or round ducts. For other sizes or rectangular shapes, the duct size can be calculated.

Square duct: $10 \text{ in.} \times 10 \text{ in.} = 100 \text{ in.}^2$

Round duct: $10 \text{ in. round} = 78.5 \text{ in.}^2$

C. All air from the outdoors via one opening.

Step 2:

- Where all air is to be taken from the outdoors using one opening, divide the total input of all appliances in the space by 3000.

Total input:

$$145,000 / 3000 = 48 \text{ in.}^2$$

Provide one 7 in. square duct or one 8 in. round duct.

Step 3:

- Check minimum clearances: side and back, 1 in.; front, 6 in.

Side and back: 1 in. Clearances OK? (Check one)
 Front: 6 in. Yes No

Step 4:

- Check that total vent connector area is less than or equal to the opening area (Step 2).

Furnace connector diameter = 5 in.
 Divide by 2 = 2.5 in.
 Squared = $6.25 \times 3.14 = 19.63 \text{ in.}^2$
 Water heater connector diameter = 4 in.
 Divide by 2 = 2 in.
 Squared = $4.00 \times 3.14 = 12.56 \text{ in.}^2$
 Total vent connector area = 32.19 in.}^2

Job: 25 Main Street

Prepared by: TL

Date: 1/1/06

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