Combustion Air

By **BRUCE BARKER, ACI**

ONCE AGAIN, The Word invites you to travel into the dark realm of issues that are sometimes misunderstood by home inspectors. The Word hopes you will find this trip informative and maybe a little entertaining.

The Word's term this month is **combustion air.** The Word finds this term interesting because combustion air is important for the safe and efficient operation of fuel-fired systems and because confusion exists about how to inspect for combustion air provisions and problems.

Remember when reading all The Word columns that we're discussing general principles. Just because something you see in the field doesn't comply with a general principle doesn't mean that what you see is wrong. Local building codes, manufacturer's instructions and engineered designs trump general principles.

Presence versus adequacy

Here's The Word's opinion, for whatever it's worth, about combustion air inspection requirements. We are required to inspect for the presence of reasonable combustion air provisions. We are not required to determine if combustion air, or any other system or component for that matter, is adequate to perform its intended function. This means that we are not required to measure combustion air openings or room volume and we are not required to calculate combustion air opening size or room volume. We only are required to determine if the available combustion air provisions appear reasonable.

So, why should we know the basic combustion air calculation rules? How else are we to know if the available combustion air provisions appear reasonable?

Combustion air's importance

Combustion air serves two important functions. First, as the term implies, combustion air provides the oxygen necessary for fuel to burn as completely and as safely as possible. Second, combustion air provides dilution air and ventilation air that helps cool the appliance and helps flues and vents create and control the draft that allows the combustion products to rise up the flue and vent and be expelled safely outside the home.

Incomplete combustion creates dangerous byproducts, the most dangerous of which is carbon monoxide. In small doses, carbon monoxide can cause health problems such as headaches and respiratory difficulties. In higher doses, it can kill. That's why carbon monoxide alarms are now required in all homes with fuel-burning appliances, including fireplaces, and in homes with attached garages. Incomplete combustion also can produce solid materials (soot) that can clog flues and vents and damage appliances.

Two important assumptions

Combustion air in older homes is often drawn from inside the home. This is no longer considered good practice for several reasons. One of the most of important of these reasons involves the first assumption, a leaky home. Most older homes exchange significant amounts of air with the outdoors. This air exchange is energy-inefficient, but it can provide adequate combustion air. As we make our homes more airtight and energy-efficient, we may inadvertently change the combustion air system that worked fine in the past. So, if you see a home with combustion air drawn from the inside and the home shows signs that it has been air-sealed or has had other energy-efficiency improvements, you may want to include a comment in your report that a combustion air test may be a wise investment.

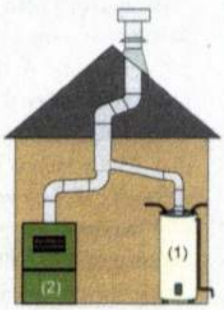
The other important assumption involves having a sufficient volume of space in the home from which to draw combustion air. Combustion appliances often were placed in unfinished areas such as basements and garages. These areas may be adequate if they remain open and unfinished. If these areas are finished and if the area from which the appliance draws combustion air is reduced in size with a wall and a solid door, the combustion air system that worked fine in the past has changed and may not be working properly now. So, if you see combustion appliances in an area that is now a utility room in a finished space, you may wish to call for a combustion air deficiency expert or recommend a combustion air test.

Wondering what the heck a combustion air test is? It's known in Building Performance Institute (BPI) lingo as a combustion appliance zone test and it's an important part of the BPI safety protocol when combustion air provisions in a home may have been changed. One part of the test simulates the worst-case combustion air conditions by turning on all equipment (such as clothes dryers and exhaust fans) that could create negative pressure in the space from which the combustion appliance draws its combustion air. Remedial measures to improve the combustion air provisions may be needed if backdrafting is detected under this worst-case scenario.

The standard method

The standard method for determining whether the area inside the home has enough volume to provide combustion air for gas- and oil-fired appliances is the familiar 50 cubic feet of

Figure 1



(1) 40,000 Btu WATER HEATER (2) 110,000 Btu FURNACE

MINIMUM ROOM VOLUME IS ≥ 50 CU. FT. PER 1,000 Btu TOTAL INPUT FOR ALL APPLIANCES

EXAMPLE:
40,000 Btu + 110,000 Btu = 150,000 Btu
150,000 Btu / 1,000 Btu = 150
150 X 50 CU. FT. = 7,500 CU. FT. MINIMUM ROOM VOLUME

Combustion Air from Room where Appliance is Located

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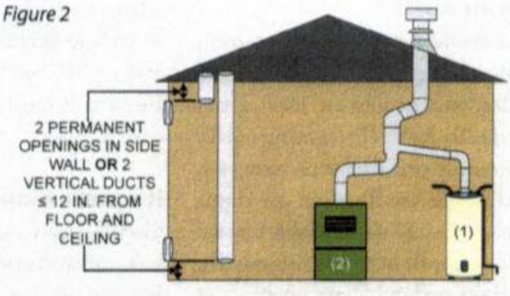
Figure 2



(1) 40,000 Btu WATER HEATER (2) 110,000 Btu FURNACE

MINIMUM AREA OF EACH OPENING IS ≥ 1 SQ. IN. PER 4,000 Btu TOTAL INPUT FOR ALL APPLIANCES

EXAMPLE:
40,000 Btu + 110,000 Btu = 150,000 Btu
150,000 Btu / 4,000 Btu = 37 1/2
37 1/2 x 1 SQ. IN. = 37 1/2 SQ. IN. MINIMUM FREE AREA FOR **EACH OPENING**

Combustion Air from Outside
Two Permanent Openings or Two Ducts

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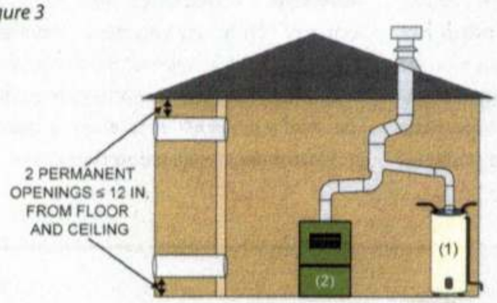
Figure 3



(1) 40,000 Btu WATER HEATER (2) 110,000 Btu FURNACE

MINIMUM FREE AREA OF EACH OPENING IS ≥ 1 SQ. IN. PER 2,000 Btu TOTAL INPUT FOR ALL APPLIANCES

EXAMPLE:
40,000 Btu + 110,000 Btu = 150,000 Btu
150,000 Btu / 2,000 Btu = 75
75 x 1 SQ. IN. = 75 SQ. IN. MINIMUM FREE AREA FOR EACH OPENING

Combustion Air from Outside – Horizontal Ducts

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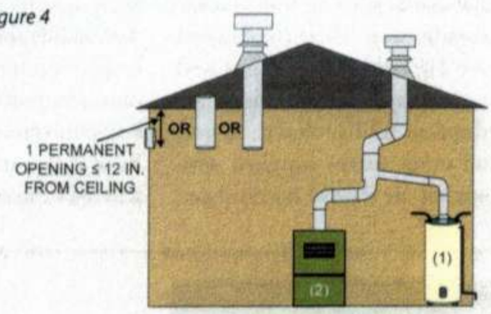
Figure 4



(1) 40,000 Btu WATER HEATER (2) 110,000 Btu FURNACE

MINIMUM FREE AREA OF THE OPENING IS ≥ 1 SQ. IN. PER 3,000 Btu TOTAL INPUT FOR ALL APPLIANCES

EXAMPLE:
40,000 Btu + 110,000 Btu = 150,000 Btu
150,000 Btu / 3,000 Btu = 50
50 X 1 SQ. IN. = 50 SQ. IN. MINIMUM FREE AREA FOR THE OPENING

Combustion Air – One Permanent Opening

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room volume per 1,000 Btu/hour fuel input rate of the appliance. This method does not apply to fireplaces and other solid-fuel burning appliances, and it does not apply to homes or combustion appliance areas that are tightly sealed against outside air infiltration.

Figure 1 shows an example of how to calculate the minimum room volume required to provide combustion air for a typical gas water heater and a medium-efficiency gas furnace. As you see, the minimum required room volume is 7,500 cubic feet. Now, let's apply this to a typical area.

Assume that an unfinished basement where these appliances are located measures 20 feet by 25 feet by 8 feet to the subfloor sheathing. We can safely ignore the floor joists. The volume of this room is the product of 20x25x8 feet = 4,000 cubic feet. This basement has about one half the required combustion air volume. Combustion air from another source is necessary.

Other combustion air sources

Combustion air can be drawn from other areas inside and outside the home through permanent openings, ducts and louvered doors. Remember that the size of openings, ducts and louvered doors is the net free area. This is the opening area minus obstructions such as screens, grates and louvers. For example, the net free area of many louvered doors is limited. Absent specifications from the door manufacturer, it's safe to assume that the net free area of a wood-louvered door is about 25% of the door's total louvered area.

Figures 2 and 3 show the familiar two-horizontal-or-vertical-ducts method of providing combustion air. What you may not be aware of is the one-duct method shown in Figure 4. This one-duct method applies only to gas appliances.

Look carefully at combustion air ducts that terminate in attics and crawlspaces. The attic and crawlspace ventilation openings should be large enough to provide both ventilation and combustion air; thus, the ventilation opening area should be larger than would be required for ventilation only. ▸▸

Combustion air ducts

The two most common combustion air ducts are 28 (minimum)-gage galvanized steel and framing cavities (stud or joist cavities). Duct installation rules include: (1) framing cavity ducts may have only one fireblock removed; (2) horizontal upper-combustion air ducts should be level or should slope down toward the combustion appliance; (3) screens for combustion air ducts should have openings at least ¼ inch; (4) no screens should be installed on combustion air ducts terminating in the attic; (5) the same duct may not serve both the upper and lower opening; and (6) combustion air ducts should open into only one combustion appliance area.

Outside combustion air and energy efficiency

The Word is amazed that even in new homes, people forget that combustion air from outside openings is unconditioned. These combustion air openings are big holes in the home and the spaces into which these holes open are unconditioned spaces. Utility closets, rooms, basements, and other spaces supplied with outside combustion air should be insulated where they abut conditioned spaces. Doors into these spaces should be weather-stripped and sealed just like any other exterior door. Be sure to look for this problem because it's easy to miss.

It's more than math

Combustion air is about more than room volumes and opening sizes. That's why a combustion air test tries to put the combustion appliance area in the worst-case condition. Different operating conditions, such as closing doors and running other appliances, can affect how a combustion appliance operates. Backdrafting and incomplete combustion may occur only under specific conditions and may occur even though the combustion air provisions appear reasonable.

So, remember to look for possible signs of backdrafting and incomplete combustion. Such signs include rust, stains or soot around draft hoods and the combustion chamber. But remember, too, that these signs can also be caused by problems other than improper combustion air provisions. It's not our job to speculate about the cause of a problem. We report problems and refer causes and cures to others.

The bottom line

Sometimes, it's easy to call a combustion air deficiency. A furnace in a small utility room in a finished basement with no source of combustion air is a good example of an easy call. Many times, combustion air is a more difficult call. Use your professional judgment and maybe some of the information in this column to make this call a little easier.

Memo to Vulcan and the fire gods: The Word does not reside on Mt. Olympus (just at its base) and welcomes other viewpoints. Send your lightning bolts or emails to inspectorbruce@cox.net. The thoughts contained herein are those of The Word. They are not ASHI standards or policies. ■

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