MINNESOTA
DEPARTMENT OF
PUBLIC SERVICE

XAVIER, INC.
P.O. BOX 510884
LIVONIA, MI 48151

Combustion air

On the inside

The fuel-burning appliances in your home need a reliable supply of outside air to work properly. Your furnace, water heater and other flame producing devices use large amounts of air in the combustion process. That air must constantly be replaced if your appliances are to operate safely and efficiently.

This replacement air is commonly called "combustion air," and its importance cannot be overemphasized. Without enough combustion air, your house can quickly become polluted with unhealthy gases, including deadly carbon monoxide.

Because carbon monoxide is odorless, colorless, very poisonous, and can be fatal, it is essential that all fuel-burning appliances – including fireplaces and wood stoves – have an adequate supply of replacement air.

No special means of supplying combustion air is provided in most older homes – the needed air simply flows in through leaks in the structure. The Minnesota building code, however, requires that all new homes be built with a special duct that brings outside air directly to the heating system.

All new furnace and boiler installations in existing homes are also required to have a combustion air duct.

What causes dangerous combustion air problems?

Most furnaces, wood stoves and fireplaces use a natural draft; the hot gases produced by the fire rise up the venting system without assistance.

This draft up the chimney creates a slight vacuum, which draws in air through small holes and cracks in the house, or through the combustion air duct (Figure 1). The most serious combustion air problems occur when this natural flow of air and exhaust gases is disrupted.

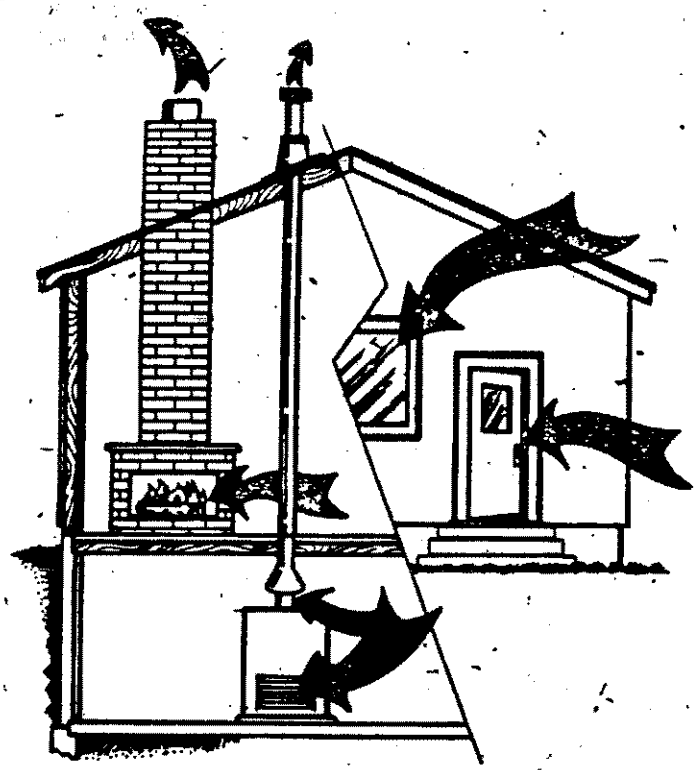
In general, combustion air problems occur any time more air is being consumed by the combustion process than is coming in through normal replacement air routes. Here is an example:

A house has been made tight through caulking, weather-stripping and other weatherization efforts, and very little air can leak in through cracks and crevices. (Remember: leaky houses can also have combustion air problems when there is no combustion air duct.)

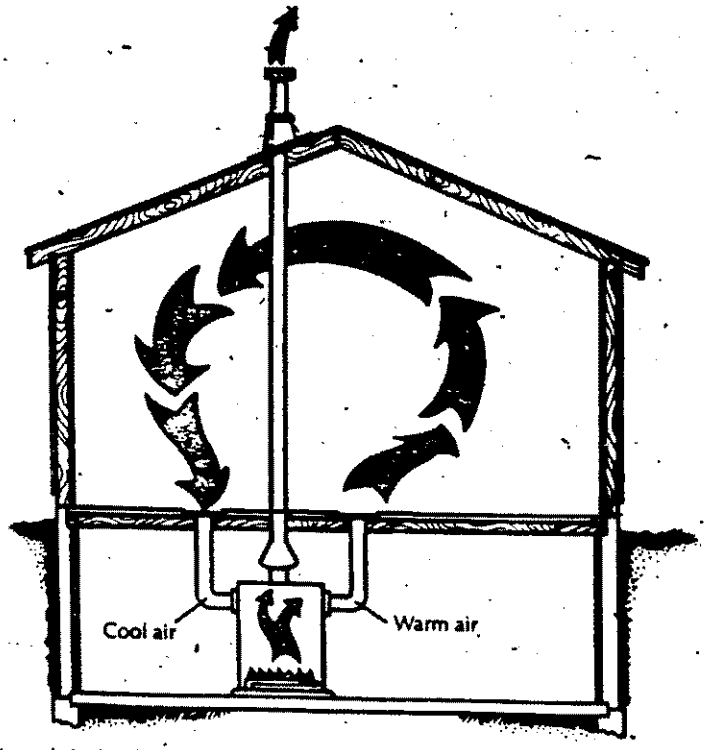
A fire is burning in the fireplace, which uses room air for combustion. The fireplace's strong natural draft sends the combustion products up the chimney. Because air is going up the chimney, a slight vacuum is created in the house.

In the past, before the house was tightened, the suction would pull in plenty of air from the outside. Usually the amount of air leaking in was far too much. There

Figure 1



Combustion air circulation



Heated air circulation

was enough combustion air, but a tremendous amount of energy was wasted, and uncomfortable cold drafts were created.

Since it is very hard to make existing structures airtight, in most houses adequate replacement air will still leak in. But this house is very tight. No doors or windows are open, and the fire is making large demands on the home's air supply.

The flue is the only air supply source left.

Eventually the furnace comes on. The natural tendency of the hot combustion gases is to rise. But because the suction caused by the fireplace's natural draft is pulling air down the furnace flue, the combustion gases spill out the draft hood and remain in the furnace area. This is called "backdrafting." The gases can eventually displace the oxygen around the furnace. Continued operation of the furnace produces increasing amounts of CO and other potentially dangerous gases.

Wood fires are not the only causes. Combustion air problems are more likely when there is an open wood fire, because a wood fire uses more air than a gas or oil furnace. But because there are other demands on the home's air supply, combustion air problems are not limited to situations where there is a wood fire.

Clothes dryers, gas stoves, gas or oil water heaters, and bathroom and kitchen exhaust fans, will all make demands on the replacement air supply. In addition, warm air leaks into the attic, called "attic bypasses," can be so strong in certain conditions, that they overwhelm the furnace's natural draft.

Don't let this potential problem discourage you from tightening your house. Weatherizing your home is an excellent investment. But be sure to have adequate combustion air supplies.

How to test for combustion air

You can easily check for combustion air by performing a simple draft hood test. The draft hood is an opening in the vent pipe above the furnace that allows room air to enter the venting system. It is usually a hood-like device in the pipe just above the furnace (Figure 2), or an opening near the

Figure 2

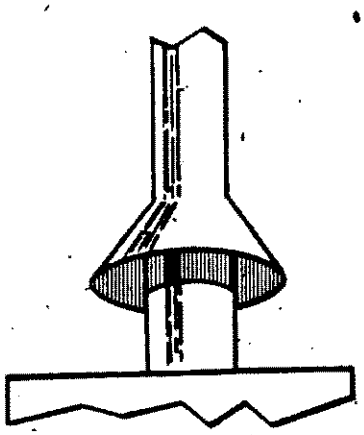


Figure 3

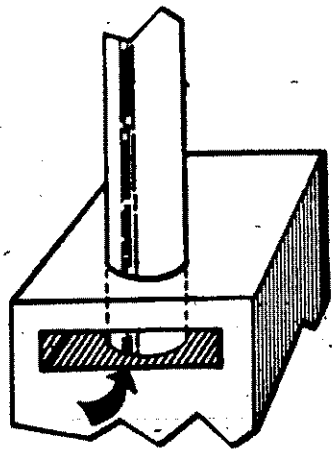
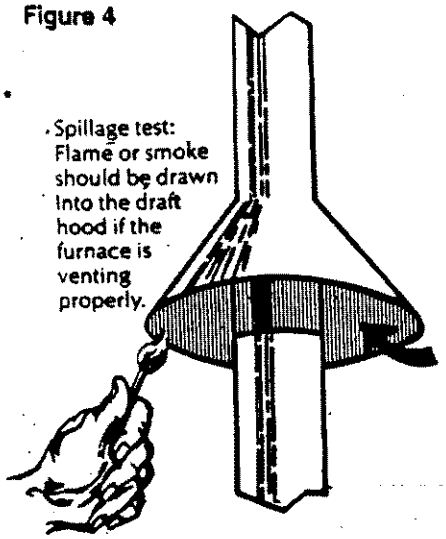


Figure 4



Spillage test: Flame or smoke should be drawn into the draft hood if the furnace is venting properly.

top of the furnace (Figure 3).

The test shows if air is being pulled into the draft hood, which means the furnace is venting properly. It is done by holding a smoking object near the hood while the furnace burner is on and watching to see if the smoke is drawn into the hood (Figure 4). If it is blown away from the hood, combustion gases are not going up the flue as they should.

You must perform the draft hood test at least twice. If you have a fireplace or wood-burning stove, you need to do it a third time. The tests should be performed on a mild day with very little or no wind.

Test 1. The first test is to simply see if the flue is clear of obstructions. Turn on the furnace and wait a minute for the draft to stabilize. Hold the smoke source two inches from the draft hood opening. If the smoke is drawn in, your flue is clear. If it is blown away from the hood, it is essential that you check the flue for obstructions before operating the furnace. Call a heating professional.

Test 2. To perform the second test, wait about an hour or so to let the flue cool. Close all doors, windows, and fireplace and wood stove dampers. Make sure all storm doors and storm windows are in place and shut. Turn on all exhausting devices, such as kitchen and bathroom exhaust fans, clothes dryers (gas or electric), and all vented gas or oil appliances, such as water heaters. You may have to turn on a hot water tap to get the water heater to come on. Open any doors between the furnace and any exhausting device. Then turn on the furnace, wait a minute for the draft to stabilize, and repeat Test 1.

If combustion gases are spilling out of the draft hood, you need to bring additional air into the house. As a temporary solution, crack open a window in the furnace room and leave it open until you can provide a permanent replacement air supply.

Test 3. If you have a fireplace or wood stove, perform the test once more. Leave the furnace off long enough for the flue to cool down. Then start a fire in the fireplace or stove and wait until the flames are burning well. Turn on all the equipment as in the second draft test, wait a minute for the drafts to stabilize, and do the test as before.

If the combustion gases spill out of the draft hood, open a window in the furnace room until you can install an outside air source. It would also be safest to use the fireplace or wood stove only with a nearby window or door open until you can provide fresh air from a permanent duct.

Even if the fireplace or wood stove passes the test, a separate combustion air

supply is still recommended for each wood burning appliance.

Other warning signs

Certain other signs may indicate inadequate combustion air, including frequent headaches, a burning feeling in your nose and eyes, and gas flames burning yellow instead of blue. Other signs are:

Oil. Black chimney smoke; fuel smell in the house; soot accumulation; outward leaking from doors or ports; popping, banging, or delayed ignition in furnace.

Natural gas. Excessive moisture collecting on windows and walls, although this often happens without a combustion air problem.

Wood. Fire smokes and doesn't draft properly even when flue has warmed up.

These problems could also be caused by clogged combustion air intakes on the furnace, problems in the fuel burning appliance, or an inadequate or damaged flue. If you notice any of these signs, you should have your system inspected by a professional heating contractor.

If you suspect a problem with combustion air, open doors and windows and air out the entire house. Then crack open a window in the furnace or fireplace room and leave it open until you can get professional advice and/or help to install an outside air duct to your furnace room, fireplace or wood-burning stove.

Outside combustion air supplies for the furnace

There are two approved ways to install an outside combustion air supply. The first method is to bring a duct from the outside to the vicinity of the furnace's combustion air inlet (Figure 5). The furnace draws combustion air through this inlet.

When installing a combustion air supply this way, the state building code requires that the outside air intake be one foot or higher than the outside ground level (A); that the intake is protected by a screen of 1/4 inch mesh (B); that the duct is at least the diameter of the flue (C); and that the supply outlet is not more than one foot above the floor (D).

Figure 5

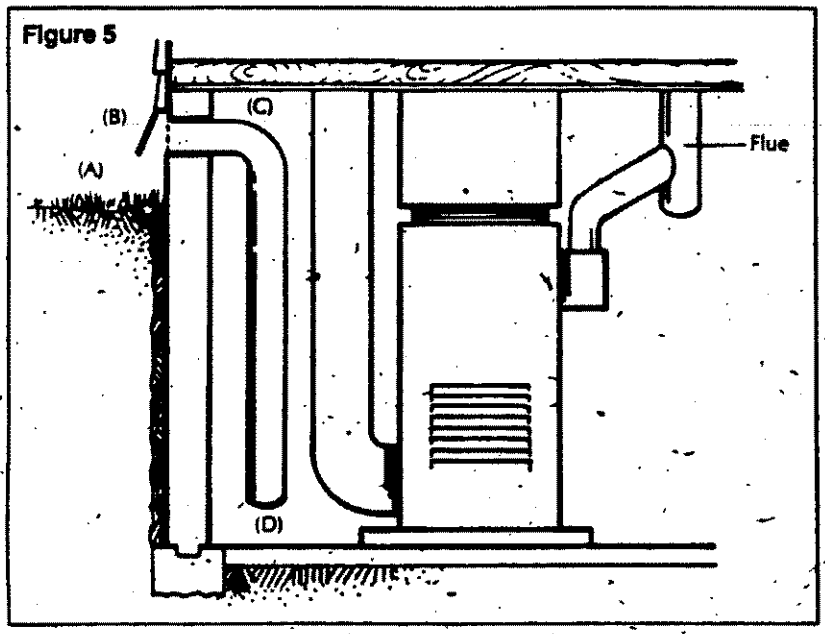
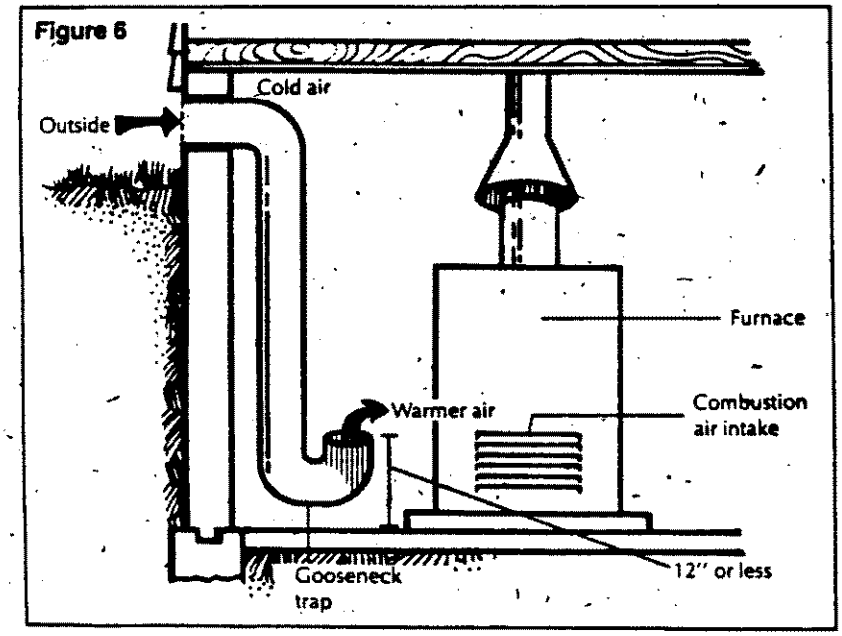


Figure 6



To reduce the amount of cold air in the furnace area, you can install a gooseneck trap, either in the combustion air supply duct or at the end of the duct (Figure 6). This helps prevent cold air from flowing into the furnace room when the burner is off. It is a good idea to cover the outlet with a 1/4-inch mesh to keep objects from falling into the duct and interfering with air flow.

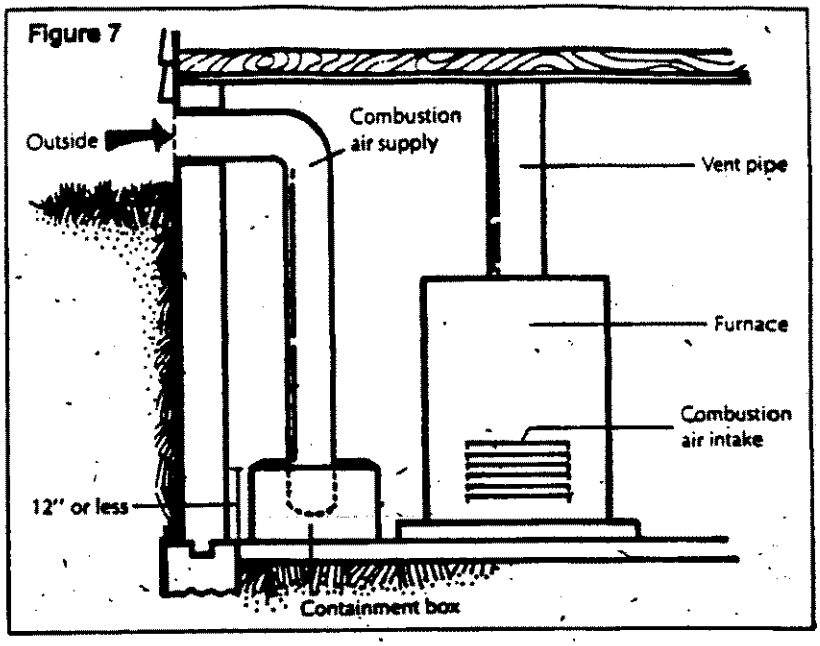
Another way to reduce cold air around the furnace is to build a closed-bottom containment box out of sheet metal and drop the combustion air supply duct into it (Figure 7). This will help keep the incoming cold air in one place instead of allowing it to spread all across your basement floor. A metal pail may also work. The box or pail cannot be more than one foot high. Attach the pipe permanently to the container.

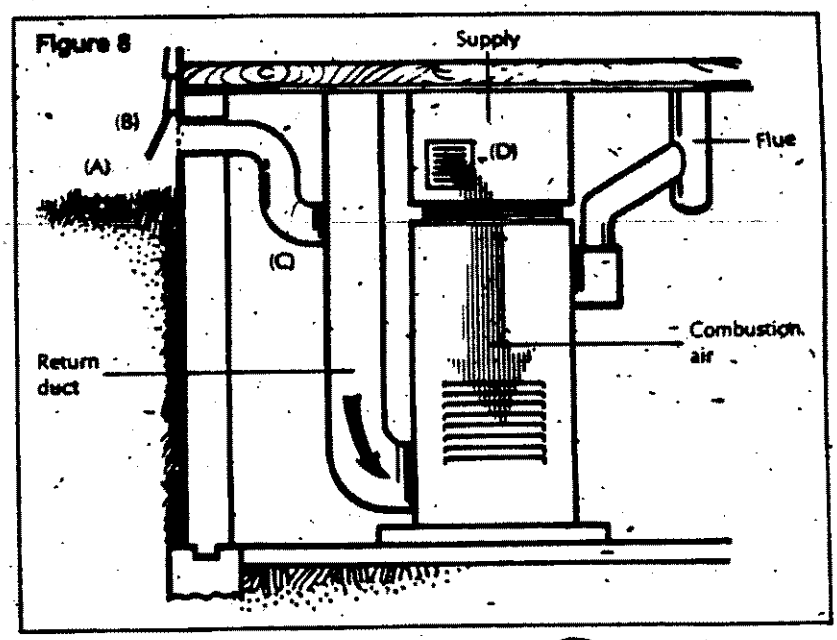
The second way to install a combustion air supply is to bring air from the outside into the return air duct (Figure 8). The return duct carries room air into the furnace to be reheated and sent back to the living space through the supply duct. With this type of installation, the furnace uses the air from outside for combustion after it has been heated.

The combustion air flows down from an opening in the supply side of the circulating air system to the combustion air intakes. When this sort of system is used, the building code requires that the outside air intake be one foot or more above the outside ground level (A); that the air intake be protected with a screen with 1/4 inch mesh (B); that the duct be at least the size of the flue (C); and that the opening installed in the plenum be unobstructed and at least half the size of the flue area (D).

In a home with central air conditioning, this option may pull in warm, humid air in the summer, since no damper is permitted in the duct. The air may increase the load on the air conditioner and reduce its efficiency. It may also increase summer moisture problems, especially condensation on cool surfaces.

If the furnace is in a small utility room or confined area, the combustion air supply can be installed in either way. If the floor area of the furnace compartment is less than two times that of the floor area of the





NOTE: Figure 8 shows how to provide combustion air for the furnace, however, there is no energy savings with this system because all the air is tempered.

NOTE: Figure 9 show how **EQUALIZ-AIR** by XAVIER, INC. is installed and provides both Ventilation and Combustion air. (P.O. Box 510884 Livonia, MI 48151)

Figure 9

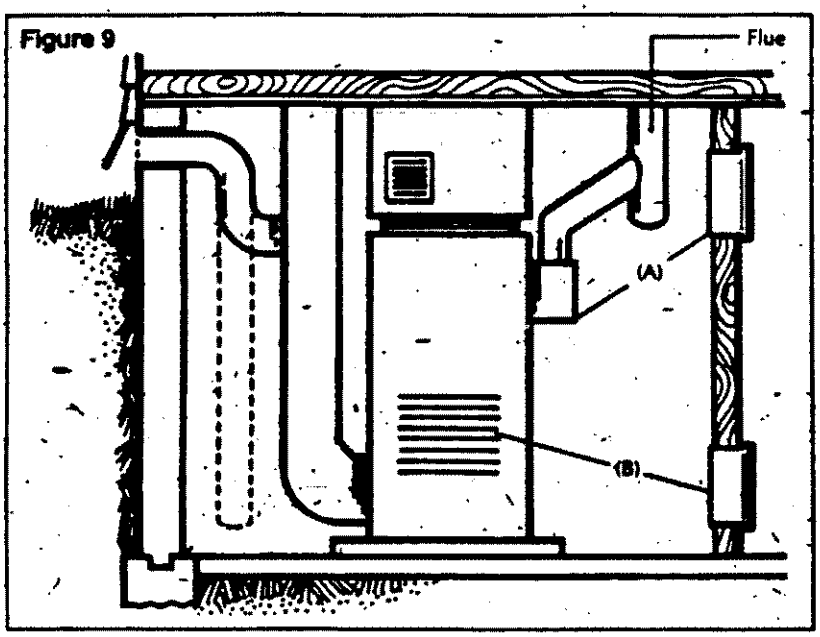
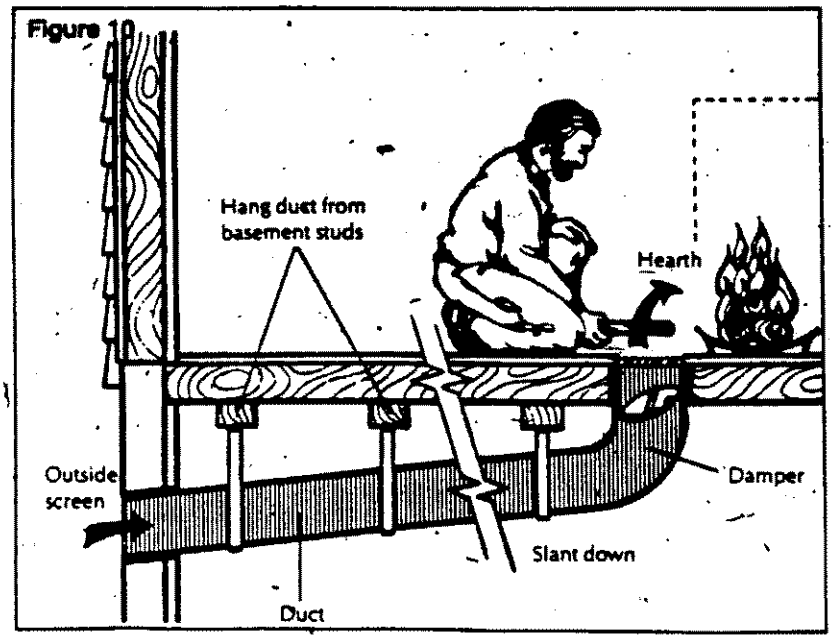


Figure 10



equipment, the building code requires that ventilation air be supplied to the confined space through two openings (Figure 9). The first opening must be placed above the draft hood opening and must be 1/2 square inch for each 2000 Btu/per hour capacity of the furnace (A). For example, an 80,000 Btu/per hour furnace would require a ventilation air grille of 40 square inches. There must also be an opening of the same size (B) at a point below the combustion air inlet on the furnace.

Sealed combustion. Some new furnace, boiler and water heater designs use sealed combustion; that is, the combustion air brought directly into a combustion chamber, much as used in an automobile engine. Do not confuse sealed combustion units with induced draft, or forced draft equipment, which still need separate combustion air ducts.

If you install a sealed combustion furnace, remember: **YOU MUST STILL SUPPLY OUTSIDE COMBUSTION AIR FOR THE OTHER FUEL BURNING APPLIANCES IN YOUR HOME.**

Outside combustion air supplies for fireplaces and wood stoves

Because fireplaces and wood stoves require large amounts of combustion air, it is an especially good idea to provide them with direct supplies of fresh air. It will make your house much safer.

With a fireplace, air from the outside should be brought in to a vent directly in front of the grate (Figure 10). The diameter of the duct will depend on the air needs of the fireplace. The duct should be connected to an air vent directly in front of the fireplace grate.

The vent should be the same size as the duct so that it can be well sealed to prevent cold air leakage. The air vent should be easy to open and close so that when the fireplace is not in use it can be closed to prevent drafts.

You can install the duct through a basement window, the rim joist or the basement wall. If you bring it through the wall, seal around the hole. If the duct is placed through a window, cut a piece of board to fit in the window and around the

duct, then weather-strip and caulk it, and insulate around it. (The window cannot be one used as an emergency exit.) You must install a 1/4 inch screen over the opening to keep out animals and debris.

A makeup air hood on the outside is strongly recommended.

The duct can be hung from the basement joists and should be tilted slightly downward toward the outside to prevent condensation from running down into the basement.

A tight fitting damper – which is allowed in a wood system – is a good idea. You can use the damper to control the amount of draft when the fireplace is in use, and to help prevent cold air from leaking in when it isn't.

Once the duct is in, take care to seal all the joints with high temperature metal tape, and insulate it with a noncombustible material. If it is possible, the air vent should be installed so that a glass door can be put on the fireplace. The vent should be between the glass door and the grate and will ensure that only outside air will be used for combustion.

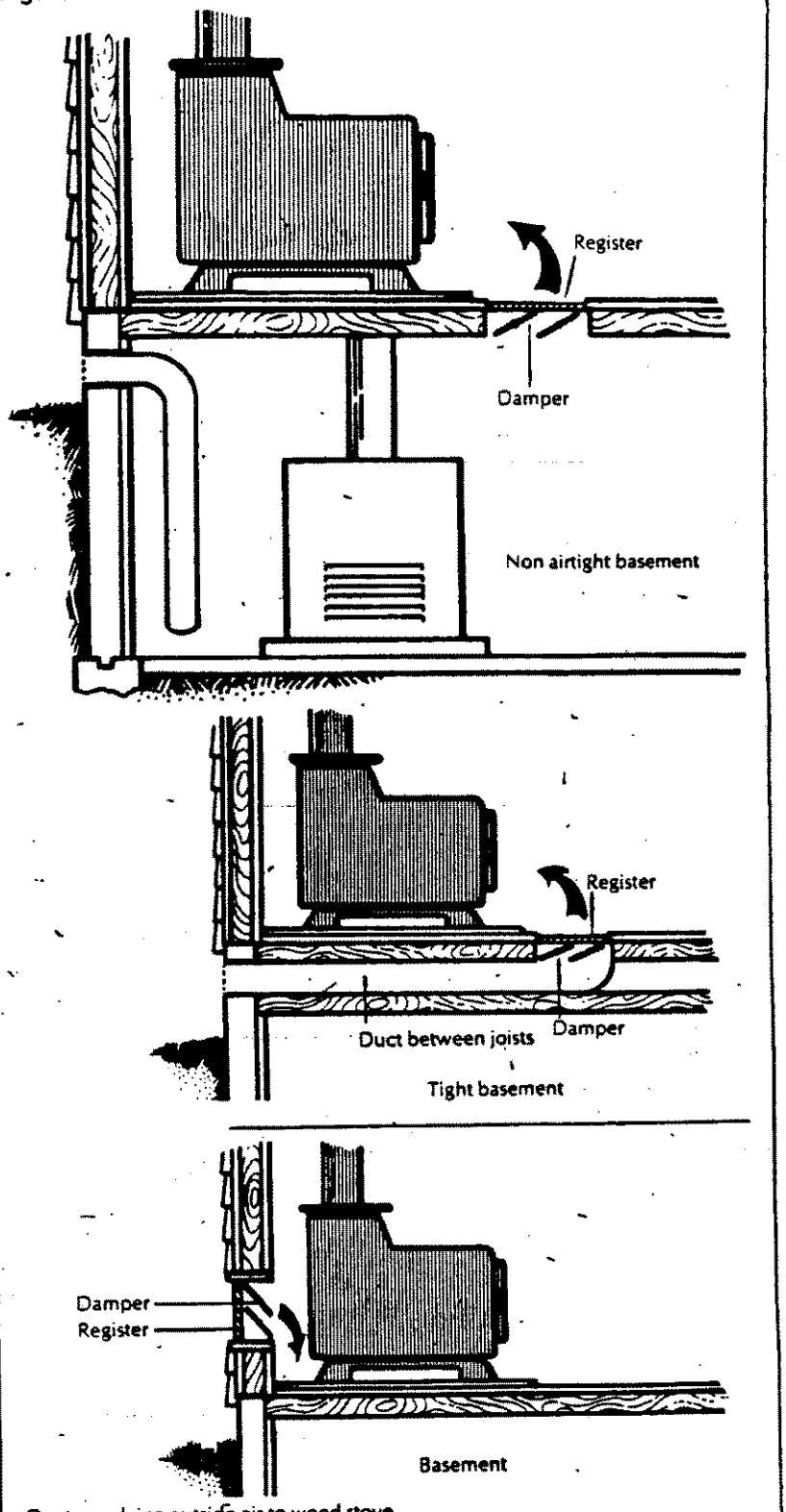
Installing an outside combustion air supply to a wood stove is basically the same as for a fireplace (Figure 11). The simplest method is through an opening either under or in front of the stove that provides an air passage through the basement or crawl space. Air can also be ducted directly from an outside wall of the house to the stove. Always install a tight damper to help control the draft and to prevent air from leaking in when the stove is not in use.

Combustion air should not be ducted directly into the wood stove unless the stove is designed for it, and then only with a proper direct connection kit.

The bottom line

Tightening up your home to save energy can make it more comfortable by eliminating cold drafts and cold walls. But don't forget that by doing so, you also change the way your heating system gets its combustion air. To make sure your furnace and other fuel burning appliances operate safely, balance the conservation changes

Figure 11



Duct supplying outside air to wood stove

with necessary combustion air changes.

Don't let this discourage you from tightening up your home. Just remember that home conservation measures have two parts: for comfort and energy savings, tighten up your home; for safety, provide enough combustion air.

Installing a combustion air supply means your heating system and other flame producing devices will not be affected by your weatherization efforts.

Energy savings

Bringing in combustion air from the outside will probably neither save nor cost energy. Energy savings occur when the vacuum pressure in the house is reduced, which reduces infiltration of cold air; when less warm room air is used for combustion; and when less warm room air is pulled into the draft hood. Energy losses occur when more cold air, which has to be heated, is brought into the house to meet combustion air requirements.

Energy Information Center
Twin Cities: 296-5175
Greater Minnesota: toll free: 800-657-3710
TDD: 297-3067

Minnesota Department of Public Service
Suite 200
121 7th Place East
St. Paul, MN 55101-2145

Remember...

- Make sure that the intake remains clear of snow, leaves, or other debris.
- Never supply combustion air from garages or other places where vehicles idle: **they produce carbon monoxide and other contaminants.**
- All fuel-burning equipment should be inspected regularly by a qualified service representative to keep it operating efficiently and venting properly. Inspect oil equipment annually, and gas equipment at least every two years.
- Never use a gas range or oven for heating a room.
- If you have a new house that has an outside combustion air opening to your furnace, never block it.
- Never use a charcoal grill inside. Burning charcoal, whether it's glowing red or turning to gray ashes, gives off large amounts of carbon monoxide.
- Wood stoves require a separate chimney. Never vent them into the existing heating system chimney.
- Never use unvented equipment indoors. This includes propane, gas and catalytic heaters, and gasoline lanterns.
- Unvented kerosene heaters should not be used indoors. Unvented kerosene space heaters are dangerous. The Energy Information Center does not recommend the use of unvented kerosene heaters in any enclosed space. Emissions of some pollutants are so high that the use of unvented kerosene heaters almost certainly constitutes a health risk, even under relatively high ventilation conditions.

This Housewarming Guide was prepared with the support of the U.S. Department of Energy, Grant Nos. DE-FG02-76CS60014 and DE-FG02-80CS69105. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author and do not necessarily reflect the views of the Department of Energy.

COUNCIL AFSCME UNION LABEL

RECYCLED PAPER WITH A MINIMUM OF 10% POSTCONSUMER WASTE

This information will be made available, upon request, in alternative format. For example: large print, Braille, cassette tape.