HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

Combustion Air

Minnesota Department of Commerce Energy Information Center

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 such as fireplaces and wood stoves use large amounts of air in the combustion process. To ensure safe and efficient operation, that air must constantly be replaced while the appliances are operating.

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 (CO). Carbon monoxide is odorless, colorless, and highly poisonous.

No special means of supplying combustion air is provided in most older homes – the needed air was simply assumed to flow in through leaks in the structure. We realize now, however, that the air in our homes is dynamic. Factors such as temperature differences between indoors and outdoors and outdoor wind speeds affect air flow, and therefore it is not safe to rely on building air leakage to provide sufficient combustion air.

The Minnesota building code requires that all new homes be built with a special duct that brings outside air directly to the heating system. This requirement makes it less likely that there will be a shortage of combustion air, but it does not guarantee it. Other fuel-burning appliances such as wood stoves, fireplaces, and water heaters need combustion air, and bath and kitchen exhaust fans affect the availability of combustion air.

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 chimney without mechanical assistance. This natural 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). Serious problems occur when this natural flow of combustion air and exhaust gases is disrupted.

In general, combustion air problems such as backdrafting of gases occur when fuel-burning appliances demand more air than the house can supply through normal air leakage. Here is an example:

A fire is burning in the fireplace, which uses room air for combustion. The strong natural draft of the fireplace sends the combustion products up the chimney; because air is going up the chimney a vacuum is created in the house. Because it is cold outside, windows and doors are shut. Eventually the furnace comes on. The natural tendency of the hot combustion gases is to rise, but the strong suction caused by the fireplace draft pulls air down the furnace flue and combustion gases spill out of the draft hood and remain in the house. This is called "backdrafting." The backdraft hinders the furnace exhaust, and the combustion gases can produce increasing amounts of carbon monoxide and other potentially dangerous gases. *(see also Wood Heat)*

Wood fires are not the only cause of backdrafting. Although combustion air problems are more like-

Related Guides:
- Wood Heat
- Indoor Ventilation
- Home Heating
- Home Cooling
- House Diagnostics

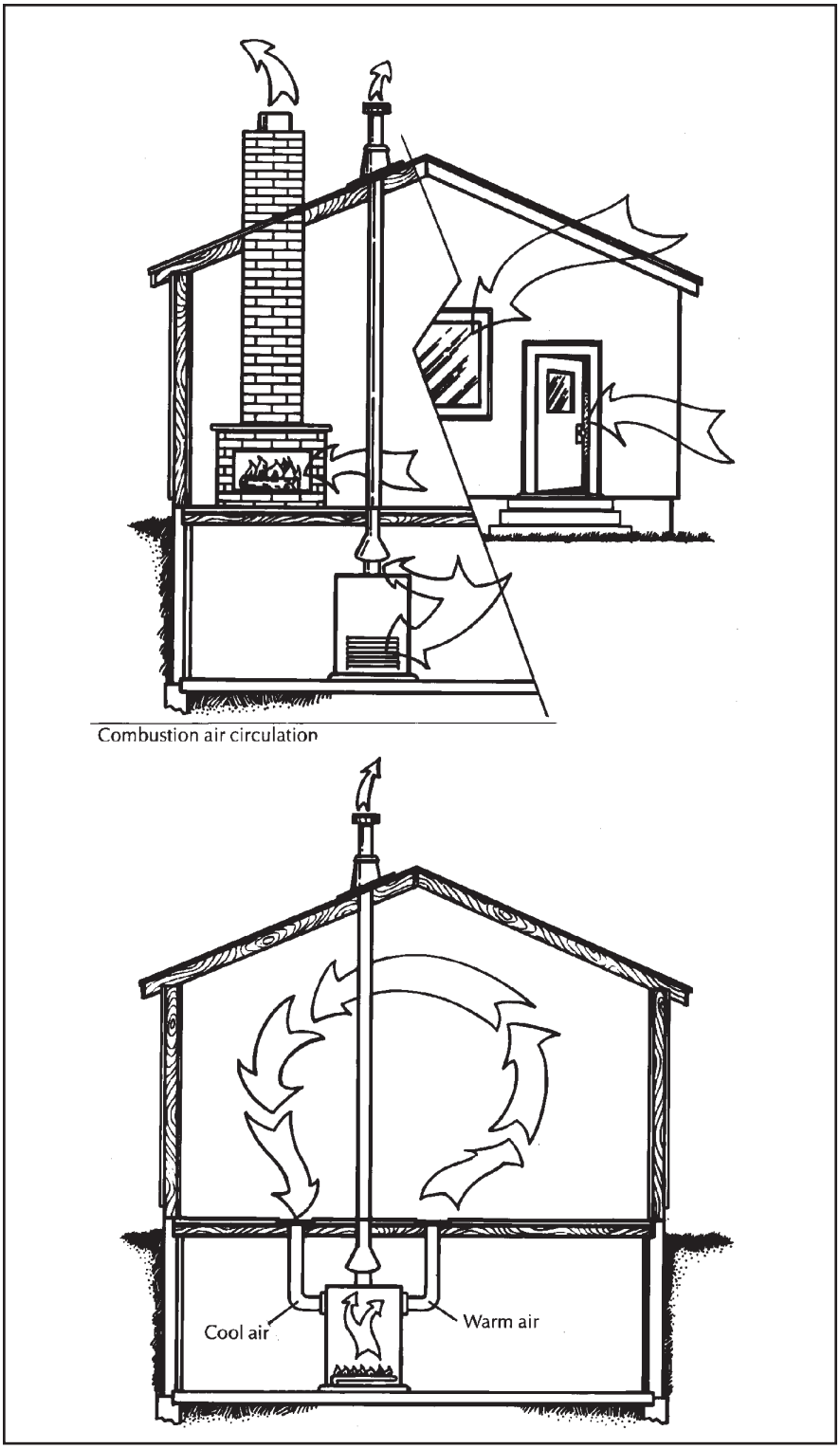


Figure 1.

ly to occur when there is an open wood fire, they are not limited to situations in which there is a wood fire. Clothes dryers, gas stoves, gas or oil water heaters, and bathroom and kitchen or range exhaust fans all make considerable demands on the air supply.

As noted above, combustion air problems can occur in any home, even older homes which were once assumed to have enough air leaks to provide outside air for combustion. Any number of home improvement or weatherization measures may increase the potential for backdrafting: for example, making our homes more comfortable and energy efficient by tightening up air leaks, adding insulation, or replacing windows. So, too, does the recent consumer trend of installing professional cooking appliances with built-in high-volume exhaust fans. These fan/exhaust systems are powerful and often remove more air from the home than what can be supplied through leaks or passive openings. It is extremely important to remember that any time we take these or other measures that affect air pressure in the home, care must be taken to provide replacement air.

How do you know if you have a combustion air problem?

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 or water heater 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 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 (such as an incense stick) 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. It is important to remember that the draft hood test is a “snapshot” of air performance in your home at one particular moment. A

change in wind speed or direction, or an open window, might change the result. It is recommended that you perform the test at least a couple of times over the heating season.

Test 1. The first test is simply to 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 the smoke is not drawn up the draft hood, you need to bring additional air into the house immediately. Open a window in the furnace room or open other basement windows or doors to the outside and leave them open until you can provide a permanent combustion 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 wood stove and wait until the flames are burning well. Turn on the furnace and 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 smoke is not drawn up the draft hood, immediately open a window in the furnace room until you can install a combustion air supply. 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 needed for each wood-burning appliance.

Other warning signs. In addition to conducting the draft hood test, certain warning signs should definitely be heeded. These include frequent headaches and a burning feeling in the nose and eyes of the human occupants, and the gas flame in the furnace or heater burning yellow instead of blue. Following are other warning signs:

Carbon Monoxide Detector

The Energy Information Center strongly recommends installing a carbon monoxide (CO) detector in the home. The detector sounds an alarm after CO reaches a dangerous level. Make sure the detector has a UL listing. You should consider buying a detector with a low level digital display and a memory, in addition to a simple alarm. These features help diagnose a problem if one is discovered. CO detectors need to be tested regularly and cleaned as indicated in the manufacturer's instructions. If the unit operates off a battery, the detector should be tested weekly and the battery replaced at least once a year. For more information on CO and its health effects, call the Minnesota Department of Health at 612-215-0909.

Figure 2

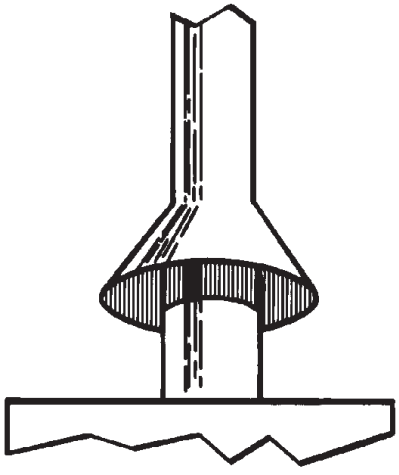


Figure 3

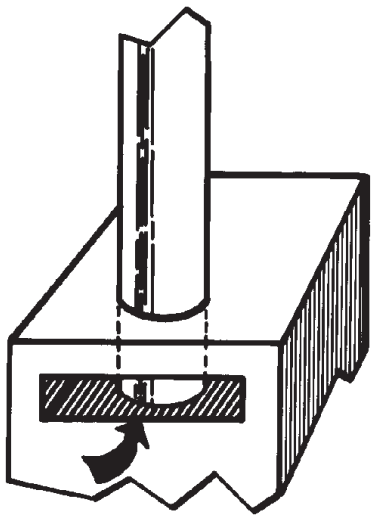
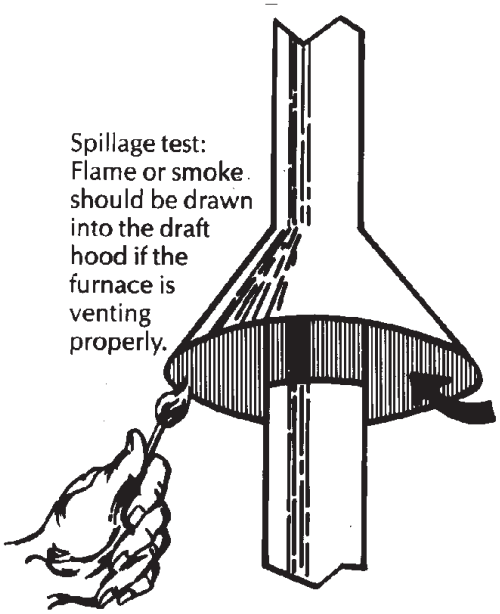


Figure 4



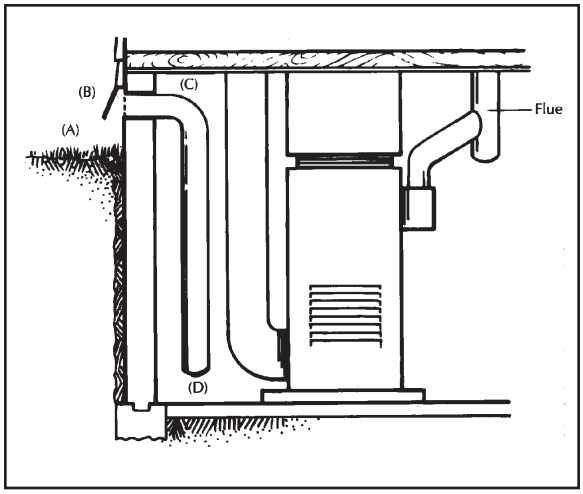


Figure 5

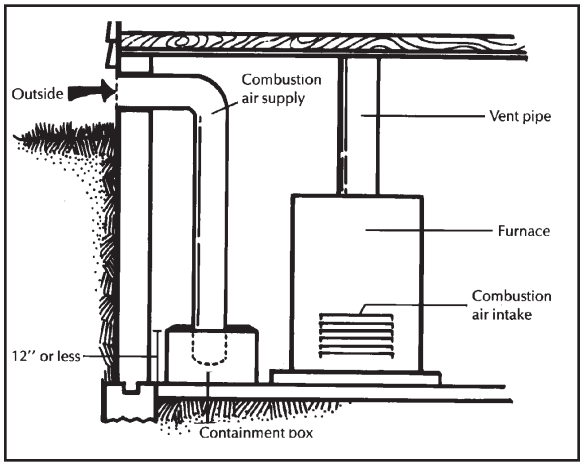


Figure 6

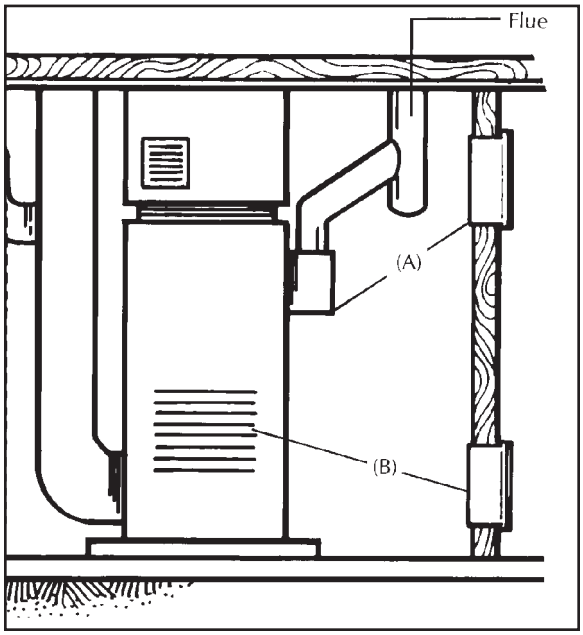


Figure 7.

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

Natural gas. Excessive moisture collecting on windows and walls, although this could be a symptom of other moisture problems and not necessarily of combustion air problems.

Wood. Smoking fire and improper drafting, even when the 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. Remember to have your furnace, water heater, and any other combustion appliance checked each year by a professional technician.

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

Whether or not you identify a problem, it is always wise to provide an outside combustion air supply.

Sealed combustion. Some new furnace, boiler, and water heater models use sealed combustion: that is, the combustion air is brought directly into a combustion chamber. Do not confuse sealed combustion with induced draft or forced draft equipment: these provide for mechanical exhaust, but not for bringing in outside combustion air. If you are in the market for a new furnace or water heater, we recommend you buy a sealed combustion or power-vented unit. A word of caution, however: even if you buy a sealed combustion furnace, you must still supply outside combustion air for the other fuel-burning appliances in your home.

Installing your own combustion air supply. If you do not have a sealed combustion furnace, you

can provide an outside combustion air supply yourself. Be sure to have your local building inspector check your work.

Two methods of installing an outside combustion air supply meet Minnesota building code requirements. The Energy Information Center recommends, however, that you use only one method, which is described below. The second method, which brings outside air into the return air duct, has two major drawbacks: it results in warm, humid air being brought into the home during the summer, increasing the load on the air conditioner and possibly causing summer moisture problems. In the winter, this same method may bring in excessive amounts of cold air, increasing air pressure within the home. This could result in moist indoor air being driven into walls and ceiling, potentially causing severe moisture problems in the house structure, including window and door frames.

The recommended method of supplying combustion air brings a duct from the outside to the vicinity of the furnace's combustion air inlet, which draws up the combustion air (Figure 5). When using this method, the state building code requires that the outside air intake (B) be one foot or higher than the outside ground level (A), that the intake be protected by a screen of 1/4-inch mesh, 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).

To reduce cold air around the furnace, build a closed-bottom containment box out of sheet metal and drop the combustion air supply duct into it (Figure 6). The box or pail cannot be more than one foot high. Attach the pipe permanently to the container.

If the floor area of the furnace compartment is less than two times that of the floor area of the equipment, the building code requires that ventilation air be supplied to the confined space through two openings (Figure 7). The first opening must be placed above the drafthood opening and must be 1-square-inch for each 2000 Btus-per-hour capacity of the furnace (A). For example, an 80,000 Btu/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.

Outside combustion air 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. *(see also Wood Heat)*

With a fireplace, air from the outside should be brought through a duct that connects to an air vent directly in front of the fireplace grate. (Figure 8). The diameter of the duct will depend on the air needs of the fireplace.

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 as long as these locations are at least 12 inches above grade. If you bring the duct 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 that is used as an emergency exit.) You must install a 1/4-inch screen over the opening to keep out animals and debris.

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 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. Combustion air and makeup air supplies are health and safety concerns and must be addressed. Buying an energy efficient, sealed combustion furnace and water heater provide energy savings as well as increased safety.

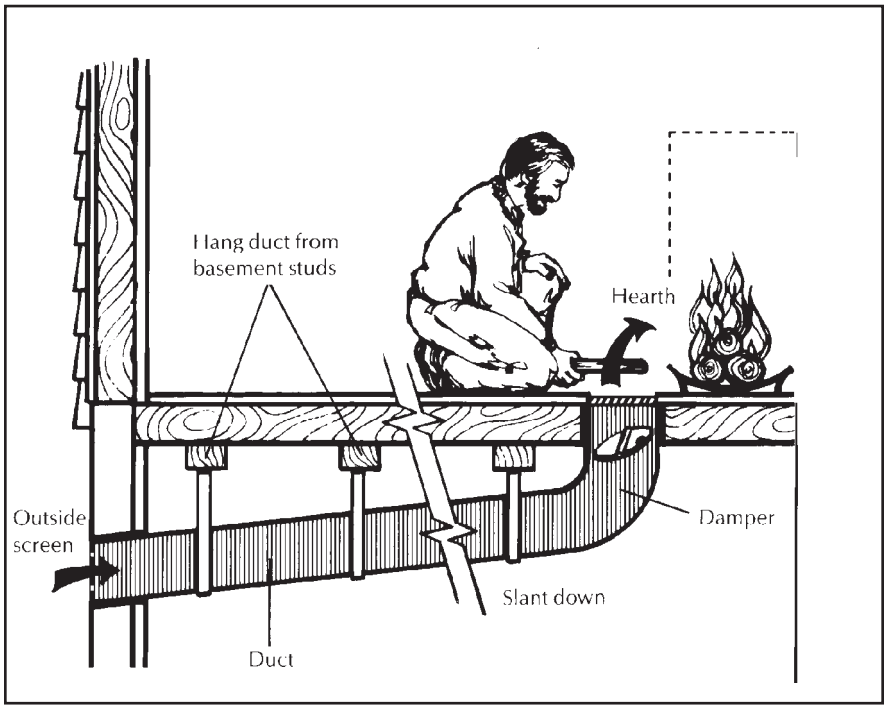


Figure 8.

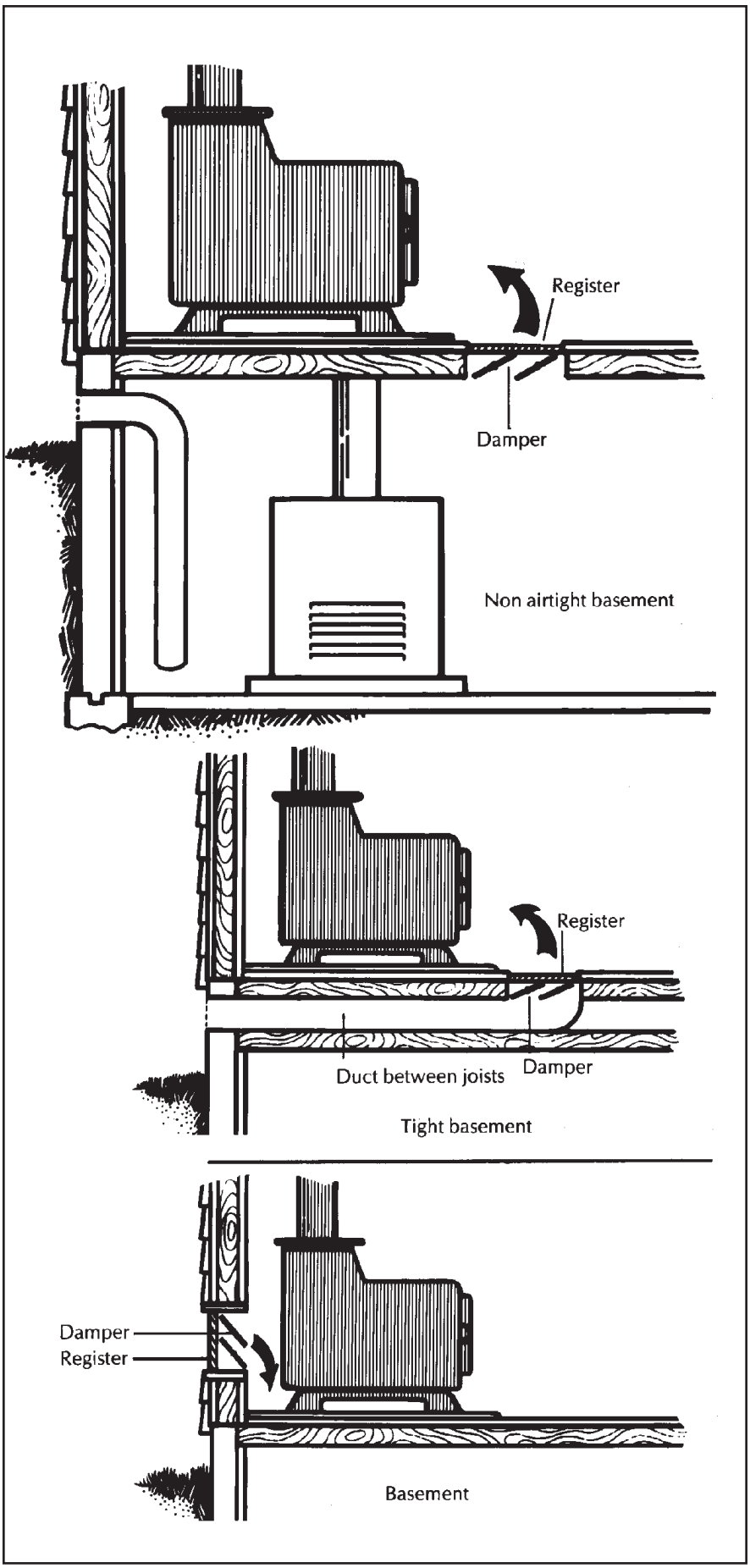


Figure 9.

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's not in use.

Once the duct is in, take care to seal all the joints with high temperature metal tape and insulate it with 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 9). 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 brought 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 brought directly into the wood stove unless the stove is designed for it, and then only with a proper installation kit.

The Bottom Line

Always remember – any time you make changes in your home that could affect the air supply, you must ensure that there is adequate combustion air. These changes include tightening up the home to eliminate drafts and cold walls, remodeling or adding an addition to the home, buying a new combustion appliance (unless it has sealed combustion), or adding an exhaust fan. Consider installing an additional source of air to make up for any air exhausted elsewhere.

Important Points to Remember

- Make sure, by checking regularly, that the combustion air 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 and gas equipment annually.
- 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 or near an air supply into the home. 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 gas lanterns.
- Unvented kerosene heaters should never be used indoors. Unvented kerosene space heaters are dangerous. The Energy Information Center does not recommend the use of any unvented heaters in any enclosed space. Exposure to emissions constitutes a health risk, even under relatively high ventilation conditions.
- Additions and remodeling change the air leakage characteristics of your home. Always test for combustion air during and after any remodeling project.

HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

HOME COOLING

Minnesota Department of Commerce Energy Information Center

Keeping cool in summer is becoming nearly as important as keeping warm in winter. Air conditioner sales continue to rise as more and more people consider an air conditioned home to be essential. Our desire for personal comfort, however, carries a price tag. As electric utilities strain to meet summer demand, they are sometimes forced to purchase expensive power from other sources or to build new power plants. The result is higher electric bills for customers and harmful environmental impacts from increased power plant emissions.

Related Guides:
Home Heating
Landscaping
Home Insulation
Combustion Air
Basement Insulation

Learning to cool efficiently will lower monthly energy bills and also help the environment. This guide presents a wide range of energy saving strategies, including passive cooling methods, effective use of fans, guidelines for purchasing air conditioners, and tips on efficient operation and maintenance of air conditioning equipment.

Passive cooling — a good place to start

Understanding how your house is affected by different types of heat gain will help you take steps to reduce heat without using mechanical cooling.

Heat is absorbed from the sun's rays, which in summer are almost directly overhead (see Figure 1). Heat also comes from warm, moist outdoor air entering the house through tiny cracks around windows and doors, numerous other small openings, and the foundation and other porous materials. Finally, heat is generated inside the home by people, appliances, lighting, cooking, and bathing.

Reducing solar heat gain. Strategic planting of deciduous trees significantly reduces heat gain from the sun's rays. Give first priority to planting shade trees due west of west-facing windows; planting shade trees east of east-facing windows is second priority. Also, installing awnings, sunscreens, or overhangs can reduce heat gain by as much as 90 percent while still letting in light. Keeping shades and curtains closed on the sunny side of the house also reduces heat gain. *(see Landscaping)*

Reducing infiltration. A good way to understand cooling is to think about how your house works in winter. The same measures that keep the cold out and the heat in during a January cold snap do the reverse in an August heat wave. Weatherizing measures to reduce air flow in and out of the house are fundamental conservation measures in any season. These include insulating, caulking, and weatherstripping. Keeping windows closed during the day (and opening at night to take advantage of cool breezes) also reduces heat gain, as well as leaving storm windows or plastic coverings on windows that do not need to be opened (the extra insulation helps keep the heat outside). *(see Home Insulation)*

Reducing indoor heat generation. Some easy cooling steps that cost little or nothing and bring immediate results are to:

- Schedule heat-producing tasks like baking and vacuuming during the cooler evening or morning hours.
- Use covered electric frypans, microwave ovens, or similar small appliances, rather than the oven, for cooking.

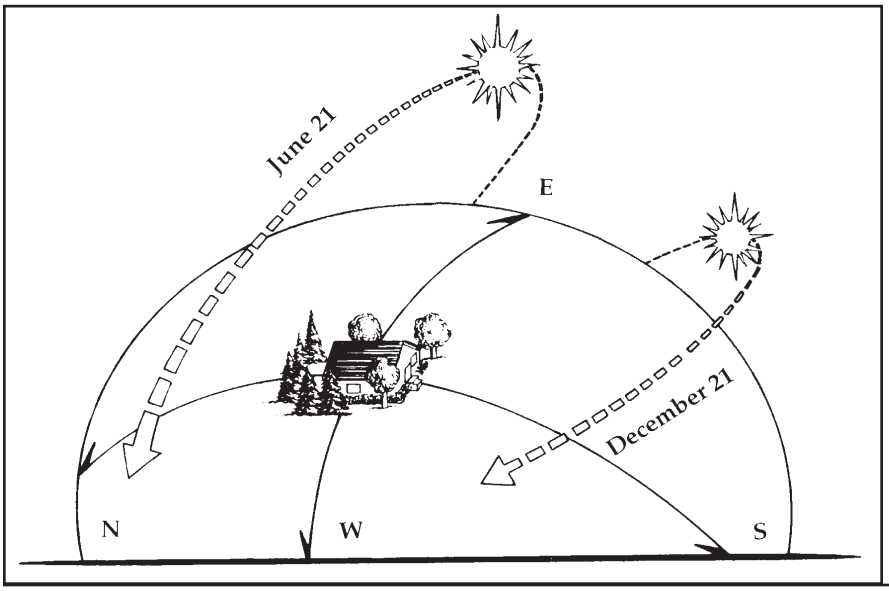
- Go easy on hot water – it produces both heat and humidity.
- Use kitchen and bathroom exhaust fans when cooking or bathing to remove unwanted moisture quickly. (See sidebar, Combustion Air)
- Reduce the use of artificial lighting (especially incandescent) because lights produce heat.
- Avoid using the dry cycle on your automatic dishwasher; allow dishes to air-dry instead.
- Make sure your clothes dryer is vented to the outside.
- Increase natural ventilation in the attic by opening attic windows or louvers.
- Drink plenty of cool liquids – they really do help keep you cool.

All of the above measures to reduce heat – from the sun's rays, air infiltration, or indoor activities – can be applied even if you have air conditioning, since they will cut operating costs.

Cooling with fans

Fans cool through circulation and ventilation. Circulating air increases the evaporation of perspiration from your skin, which is why it feels good to sit in front of a fan. In cooling a large space, however, it is more effective to use fans for ventilation.

Figure 1.
The seasonal path of the sun has a major effect on home heat gain.



Portable window fan. For about $30 you can create cross ventilation with a portable window fan, making this an excellent and inexpensive cooling method, especially during the night or after a rain storm when the outside air is cooler than indoors. Place the fan in a window on the coolest side of the house, using it to pull cool air in and push hot air out through open windows on the warm side of the house. When used correctly, window fans can cool several rooms at once. One caution: using a fan to push air out of the house can create negative air pressure in the house, leading to backdrafting. (See sidebar, Combustion Air)

A ceiling fan is quieter than a portable fan and is safely out of the reach of children. When used along with air conditioning, ceiling fans circulate the cooled air effectively, making the space feel cooler. This may allow you to set your thermostat a few degrees higher, thereby saving energy and money without sacrificing comfort. The table below will help you choose the correct size ceiling fan. Fans should have multiple speed settings so that air flow can be reduced at lower temperatures.

Ceiling Fan Sizing

Room area (sq. ft)	Minimum fan diameter (inches)
100	36
150	42
225	48
375	52
400+	2 fans

A whole-house fan is no longer recommended. Cutting a hole in your ceiling to install the fan often creates another "attic bypass" or source of heat loss in the winter, since it is very hard to seal around the fan. Whole-house fans also may create negative pressure in your house which can cause harmful backdrafting of appliances. (See sidebar, Combustion Air)

Attic fan. Using an attic fan (which is not the same as a whole house fan) to cool your house is of doubtful value. The fact is, there should not be any active relationship between the attic air and the air in your living space. It is true that adding an attic fan will help pump hot air out of the attic, lowering the attic temperature and perhaps

reducing heat in the top floor of the home; however, because most homes have some attic bypasses (openings through which air from the living space leaks up into the attic), the fan will pull cool air through the insulation, which could lead to backdrafting. (See sidebar, Combustion Air)

Although attic fans are not generally recommended, attic vents_*are* recommended. They help keep the attic cooler above the insulation and reduce moisture in the winter. If your attic has a vapor barrier, one square foot of outside ventilation should be provided for each 300 square feet of attic area. If there is no vapor barrier and the roof has less than a three-foot rise from eave to peak, one square foot of ventilation is needed for each 150 square feet of attic floor space.

Room air conditioners

Those who want more cooling than the above measures provide will look to air conditioning. One option is to purchase a room air conditioner to fit in a window or wall.

Sizing. Oversizing is the most common mistake made by shoppers, who think that "bigger is better." In fact, buying too large a unit is not only expensive, it can increase discomfort by not removing enough humidity from the air, leaving you feeling cold and clammy. An air conditioner's primary tasks are to cool and dehumidify, but a typical unit is much more efficient at cooling. Since the major control in an air conditioner is a thermostat, not a humidistat, the unit comes on and shuts off in response to air temperature, regardless of humidity level. A system that is too large often achieves the desired temperature before the humidity is adequately removed. If a system is too small it may dehumidify well, but not cool the air sufficiently. In a properly sized unit, the operating cycle should be long enough to remove heat and humidity.

Air conditioners are sized according to Btus of heat removed per hour, or in "tons" of refrigeration, with one ton equaling 12,000 Btus per hour. The load on the unit determines the size you need. The load has two parts: the energy it takes to cool the air (sensible load) and the energy required to dehumidify (latent load). Together, the sensible and latent loads total 100 percent of the air conditioner's load.

Your first step is to carefully determine the size of the area to be cooled, making sure to close off unused rooms or areas where cooling isn't necessary. As a rule of thumb, based on size alone, an air conditioner should have 20 Btus for each square foot of living space. Keep in mind, however, that this formula is simply a rule of thumb. A number of factors, such as the amount of shade around your house, window area, amount of insulation, or the size of your family means that you may have to go one size larger or smaller.

Efficiency. All new room air conditioners are required by law to carry an Energy Guide label showing the energy efficiency ratio, or EER. This bright yellow label lists the EER and compares it to the EER of models with similar features. The higher the number, the more efficient the appliance. The Energy Information Center recommends purchasing a model with an EER of 10 or higher. The Energy Guide label also lists the average yearly operating cost, based on average electric rates.

Wiring requirements. Since air conditioners consume large amounts of electricity, they may require too heavy a load for some circuits. Make sure the unit you buy will not cause an overload. In some cases you may need a special circuit with a separate fuse. Newer homes built to newer building codes have at least 100 ampere, 220 volt service, but many older homes have only 30 ampere, 110 volt service. Be sure to ask an electrician about the adequacy of your home wiring.

Installation. Always follow the manufacturer's instructions, since each unit has its own specific installation requirements. Location is also a key factor in operating efficiency. Ideally, window units should be placed in the middle of the area to be cooled and on the north or shady side of the house. Do not obstruct the free flow of air around the unit.

Operating tips for maximum efficiency include:

- Use a table or wall thermometer as a guide in selecting the air conditioner setting (room air conditioners don't come with thermostats calibrated by degrees). Keeping the indoor temperature within 17 to 20 degrees of the outdoor temperature on extremely hot days is important. You will be cool and at the same time save

Combustion Air – A Concern Year-round

All fuel-burning appliances need a supply of fresh air for the combustion process; a shortage of fresh air can cause the appliances to backdraft dangerous gases – including deadly carbon monoxide – into the home.

Although a shortage of combustion air is often associated with the heating season, when houses are shut tightly against the cold, backdrafting can – and does – occur year-round. Following are precautions which apply specifically to summer cooling practices.

Using fans to exhaust air from inside the house can create negative air pressure, resulting in backdrafting of a fuel-burning appliance – most often the natural gas water heater. Open windows may not provide a sufficient amount of make-up air for the fan. Attic exhaust fans also pose a problem, since standard passive air vents into the attic do not supply sufficient make-up air. The result may be the suction of cool air from inside the home up into the attic, possibly creating negative pressure in the home and the potential for backdrafting.

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energy and avoid overworking the unit to the point where it may break down.

- Check the filter once a month and clean as needed. Usually the filter is located just behind the front grill and many are washable. A dirty filter can significantly reduce the efficiency of the unit.
- Set the fan speed at low or medium, if you have the option. That will move the air across the cooling coils more slowly, enhancing dehumidification.
- When you turn the conditioner on, don't set it on the coolest setting thinking that the room will cool off faster – it won't.
- Keep windows and doors closed to block the infiltration of hot air; remember, the more space you cool, the more electricity you use. If the air conditioner has the capacity to cool more than one room, but you are using only the room it is in, close the doors to connecting rooms.
- Avoid blocking air circulation with furniture or draperies placed in front of the conditioner.
- Clean the condenser (the outdoor section of the unit) every year, removing dirt, leaves, grass, and the like. Your owner's manual should provide cleaning instructions.
- Install a timer to automatically control operating times so that the conditioner does not run while you are away from home. Timers can be bought at most hardware stores for $10 to $30.

Central cooling

Central air conditioners are designed to cool, dehumidify, and filter the air throughout your house. Generally, these systems are more expensive and use more energy than room air conditioners, but the costs can be minimized by following the same guidelines as for room units: buy the right size, choose a high efficiency unit, locate the unit properly, and maintain it well.

Sizing. Central air equipment is usually purchased through a heating/air conditioning contractor who is responsible for calculating what size unit you need. Ask your contractor if he or she is using the sizing guidelines described in "Manual J" (available from the Sheet Metal Air Conditioner Contractors' Minnesota Association, phone 612-593-0941). Make sure the following factors are considered in the sizing calculations:

- Size of area to be cooled.
- Amount of insulation in the attic and walls.
- Tightness of the home: very leaky, average, or very tight.
- Window area, particularly on the south, west, and east sides of the house. The larger the window area, the greater the solar heat gain. Also consider whether the windows have double

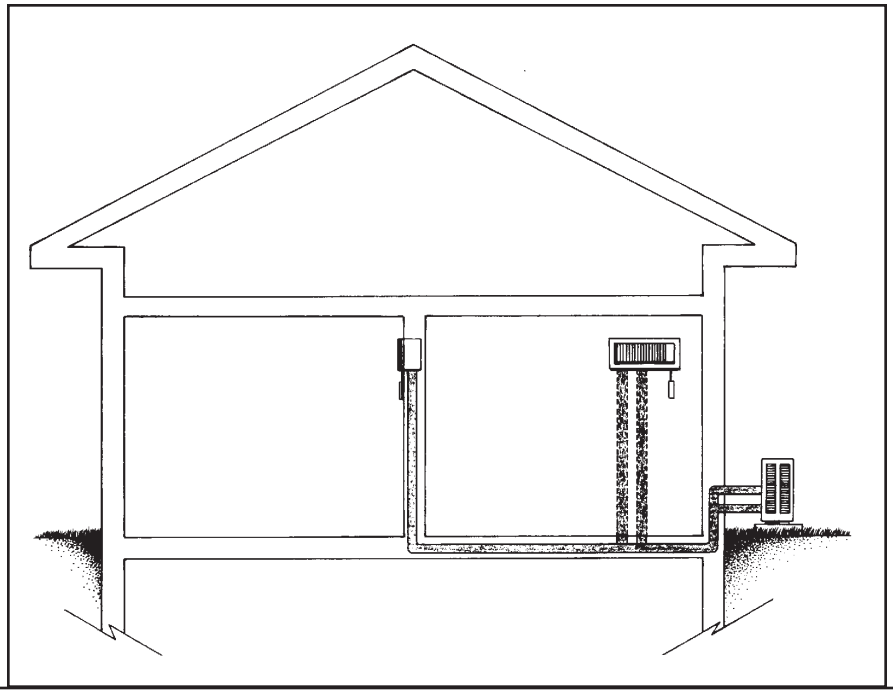

Figure 2.
A ductless system provides quiet room cooling with wall mounted units and an outdoor condenser.

panes, low-e coatings, and other features that enhance efficiency.

- Orientation of the house. A sunny exposure requires a bigger unit, especially if the windows are not shaded.
- Amount of shade. Trees, fences, shrubs, and other landscaping features, as well as window shades, may reduce heat gain.
- Family size and lifestyle. Larger families release more heat energy into the house from body heat and activities such as showers and cooking.

Also, make sure your house has the proper wiring. Central air conditioning requires a separate circuit and is operated on 220 volts.

You should obtain bids from at least three contractors, not only to compare costs, but also to make sure that you are getting the right size unit. The size estimations should be fairly close; if they are not, find out why.

Efficiency. After you determine the proper size, compare efficiency ratings of different models with the same capacity. Even though the more efficient unit may be higher priced, it is usually the best buy because high efficiency units cost less to operate. Central air conditioners are rated according to their Seasonal Energy Efficiency Ratio, or SEER. The Energy Guide label lists the SEER and compares it to SEERs of similar models; it does not, however, list an annual estimated operating cost. The Energy Information Center recommends buying a central air system with a SEER of 12.5 or higher.

Installation. The installer should always follow the manufacturer's instructions. Location is also important. If possible, place the condenser on the north or shady side of the house. Always make sure to allow for plenty of air circulation around the condenser.

Operation and maintenance. To improve efficiency and keep equipment running smoothly, follow these guidelines:

- Replace or clean filters monthly.
- Remove dirt and dust from outside coils and fins.
- Keep all return and supply registers clean and unobstructed by furniture and draperies.
- Install a setback thermostat that will turn the air conditioner on one hour before you come home each day.
- Have a qualified service person tune-up the system at the same time as the furnace tune-up is done.

Types of central air systems

Described below are the major types of central cooling systems used in this area. They provide the same benefits, but differ in configuration. The traditional type, generally costing around $1,600, uses the same ducts and registers as a forced air heating system. The ductless systems range in cost from $2,500 to $5,000 installed and are basically a combination of room and central cooling, offering an alternative for homes without ducts and registers. A third type, heat pumps, costs $2,000 or more and both cools and heats the home through a two-way heat transfer system using air, water, or ground. Ground-source heat pumps use the ground as the heat source/heat sink, depending on the season, and operate with great efficiency. Although the purchase price is high, these pumps may be cost effective in many installations.

Traditional, or forced air system, is the most common in our area and the likely choice if you have a forced air heating system. The condenser unit is outside, while the evaporator (the cooling component) is installed in the furnace. The same duct work used for heating is used to distribute cool air throughout the home. (Home owners should be aware that leaking air ducts affect efficient distribution of cooled air, as well as pose a potential backdrafting problem. See sidebar on Combustion Air).

Ductless systems are appropriate for homes with hot water or steam heat or those divided into separate areas (see Figure 2.) This type of system distributes cool air to selected portions of the home without the need for ductwork. Instead, small diameter tubes (5/8 to 7/8 inch) run between the outdoor condenser and the indoor wall-mounted unit, forming a closed loop system. The cooling component(s) is mounted on the wall of one, two,

Combustion Air (Con't)

Central air conditioning, forced-air systems, also present a potential backdrafting problem. Leaks in return air ducts have been identified as a cause of backdrafting year-round, since they add to air depressurization in the basement. In addition, they lead to inefficient and ineffective cooling. This is how it works: When the air conditioner runs, cool air leaks out of supply ducts and sinks to the lowest level of the house. In addition, leaks in return ducts draw cool air back to the central air conditioner coil before the cool air ever reaches the upper floors. The result of both supply and return duct leaks is a cold basement and difficulty in keeping the rest of the house –especially the upper floor – sufficiently cool. This, in turn, leads to the air conditioner being run longer, resulting finally in higher energy costs.

For more information on combustion air problems and leaking air ducts, call the Energy Information Center and ask for the publications Combustion Air and Duct Sealing.

The CFC Dilemma

CFCs (chlorinated fluorocarbons), a commonly used refrigerant, have been identified as a major factor in depleting the earth's protective ozone layer. By international agreement, CFCs are being completely phased out. Alternative refrigerants comparable to CFCs in safety, cost, and efficiency, but without their harmful effects, are available in some models. Ask your dealer for details on the air conditioner you are considering.

or three rooms and resembles a room air conditioner, but is much quieter. The condenser is installed outdoors, like that of any central air conditioner. Some ductless systems will support multiple terminals having a total cooling capacity equal to traditional forced air systems. An advantage of the ductless system is the easy ability to "zone" or cool only those areas in the home you are using. Other systems require additional investment for the ability to zone.

A high velocity system is another option, especially attractive to those who want central air conditioning but do not have a forced air distribution system. The high velocity system uses smaller ductwork, sometimes flexible insulated duct. Main trunks may be only six inches in diameter, with delivery ducts possibly only three inches in diameter. The ducts are supplied with air from an air handler using a higher velocity fan. The air conditioning cooling coil is installed within the air handler. The smaller flexible duct allows for smaller openings in walls and ceilings. Proper sizing of cooling equipment is always important, but it is critical with high velocity equipment.

Heat pumps in general can be used successfully in Minnesota – with certain conditions. A heat pump looks and operates like a central air conditioner, but it can be used for heating as well as cooling. During the heating season, the heat pump extracts heat from the outside air (or from a water supply or the ground) and brings the heat into the house where it is distributed through a duct system. In the summer, the heat pump cools the house by moving heat from the inside to the outside air (or water or ground) using a basic closed loop refrigeration cycle. In Minnesota, air source heat pumps are used for whole house cooling, but must be supplemented by another heating system during the winter.

Currently, the most effective type of heat pump for our climate is the ground-source system which uses the earth as its heat source in the winter and as a heat sink in the summer.

Ten Common Questions and Answers

Following are answers to the 10 most-often-asked questions on cooling received by the Energy Information Center.

What size air conditioner should I buy?

"Smaller is better" is the rule to follow for residential users. Smaller units run in longer cycles, which is better for humidity control and efficiency.

How important is efficiency? Is it worth the extra money?

Even though efficient units cost more initially, they cost less to operate, so you save money over the life of the unit. For example, choosing a room unit with an EER of 11 rather than 9, will save you 18 percent a year. Also, keep in mind that many utilities offer rebates if you purchase high efficiency air conditioners.

Can I cool the house with two room air conditioners?

Maybe, but it may not be cost-effective. Although fans can help circulate the cool air to other rooms, electrical costs can quickly exceed those of a central air system, so make sure to weigh cost and benefit. If you choose to cool with multiple room units, close off unused rooms and size the units according to the entire space to be cooled. Don't expect a unit designed to cool a single room to be able to cool a number of rooms adequately.

What is the latest advance in residential air conditioners?

Major manufacturers of residential central air conditioners make and market "scroll" condensers in two- to five-ton sizes. Scroll condensers have fewer moving parts than the traditional rotary condenser. They come with SEERs of 10 to more than 13.

How much will it cost to operate an air conditioner?

Operating costs are determined by the size of the unit, its efficiency, and the cost of electricity.

A typical 30,000 Btu (2-1/2 ton) central air system with a SEER of 10 will cost about $.21 (at $.07 per kWh) for each hour of condenser operation. This equals $137 for 650 hours of cooling in a typical Minneapolis/St. Paul summer. A typical 8,000 Btu room air conditioner with an EER of 9 will cost $.08 per hour, or $52 for the summer.

Does my air conditioner need to be "tuned?" If so, what should the service person do?

Yes, your air conditioner should be "tuned" regularly. Hire a professional service person every two years to do the following:

- Clean the interior and exterior coils (dirt and dust act as unwanted insulation, making the necessary heat transfer difficult).
- Check the amp drawn by the unit to see that it does not exceed the manufacturer's rating.
- Check the belts, bearings, and electrical connections, adjusting as needed.
- Check for refrigerant leaks and add if needed. If your unit has a leak, make sure your contractor collects and recycles the refrigerant.

What should I look for in my warranty?

Look for the following three points:

- Parts include all the electrical components, typically covered for one to two years, and coil, typically covered for five years perhaps as much as ten years.
- Condenser, typically covered for five years but may be as much as ten years for high efficiency condensers.
- Labor, which varies from contract to contract, so look for any limitations in labor cost coverage.

Many utilities offer a service contract for parts and labor that may be more useful than an extended warranty. Also keep in mind that a longer warranty may not mean that the equipment is better, only that it is more expensive.

Can I cool off by putting ice in a large bowl and blowing a fan across it?

In the short term, yes; in the long term, no. The melting ice absorbs a lot of heat from the air while the evaporating water adds humidity. Consequently, you are merely changing the form of discomfort.

If you put ice in a sealed container such as a gallon glass jar with a tight fitting lid, you can cool off with a fan blowing across the jar and at the same time keep the humidity out of the surrounding air.

Is it better to have my window fan blowing into or out of the house?

Place the fan so that it blows cool air into the room.

Will an attic fan make my home cooler?

Perhaps, but only the top floor. Attic fans pull hot air out of the attic, decreasing the amount of heat coming through the ceiling but also increasing your electric bill.

Super Saver Switch

"Super Saver Switch" and similar programs have become popular among residential electric customers using air conditioning. These programs offer customers substantial discounts for allowing the utility to control their air conditioners during periods of high demand. The utility cycles the condenser off and on in a manner that allows for comfort and at the same time alleviates pressure on the utility's generation capacity. Contact your utility about the availability of such a program.

One caution is needed for homes in which the central air conditioner uses the same duct system as the heating system. For those who do not have a sealed combustion furnace, the combustion air supply for the furnace is often brought into the home through the cold air return line. When the condenser is shut off by the utility, the furnace fan, which brings in the combustion air supply, continues to run. As a result, warm moist air is drawn in through the combustion air supply, increasing temperature and humidity in the home. Consumers with this arrangement should consider changing the combustion air supply system to one which brings the air to the furnace area. The Home Energy Guide, Combustion Air, describes how this can be done.