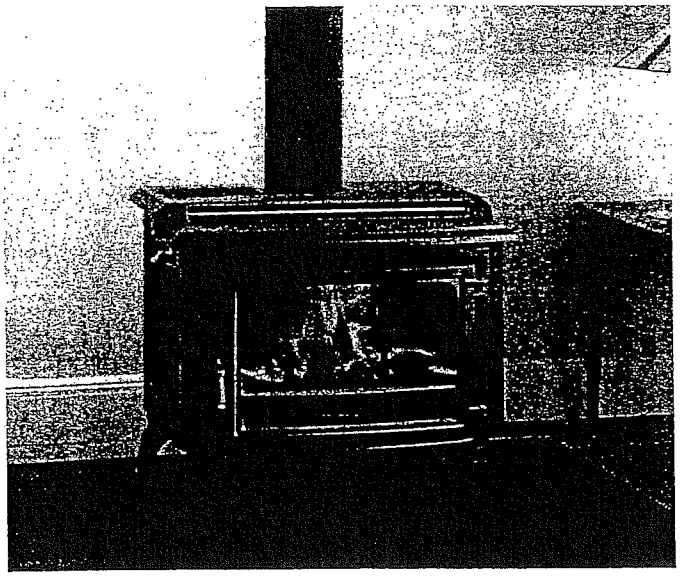
WOOD BURNING HANDBOOK

How to Burn More Efficiently In Your Stove or Fireplace and Produce Less Air Pollution



Wood Smoke Pollution Problems

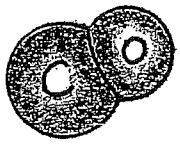
Clean Burning Operating Tips

Get More Heat for Your Fuel $$

What is Woodsmoke? It's AIR POLLUTION!

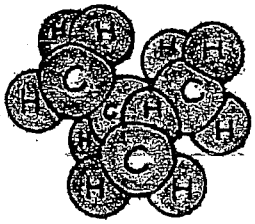
It's Also Fuel from Your Firewood Which Has Escaped Burning...

Complete combustion gives off light, heat, and the gases carbon dioxide and water vapor. Burning wood produces the above, and, because wood burns only partially in most cases, it also produces **the following major air pollutants:**



CO - carbon monoxide - odorless, produced in large amounts by burning without enough air, **CO reduces the blood's ability to supply oxygen to body tissues.** Small amounts in the air can stress your heart and reduce your ability to exercise. Those most at risk from CO poisoning are the unborn child, and people with heart, circulatory or lung disease, or anemia.

NO_2 - nitrogen dioxide - impairs proper functioning of the respiratory system and its ability to fight infection. NO_2 and NO combine with VOCs to make **ozone** and with water vapor to form **acid rain** or acid fog.



VOCs - Volatile Organic Compounds - evaporated carbon compounds **(some toxic - see below)** which react with NO_2 and NO in sunlight to form ozone, or photo-chemical **smog. Ozone injures the lungs and makes breathing difficult, especially in children and exercising adults.**

Woodburning also produces **Inhalable Particulate Matter** (PM10), microscopic solid or liquid particles 10 microns in diameter or smaller. **Most smoke particles are VERY small droplets of condensed organic vapors (wood tars and gases), unburned fuel which escaped from the fire.** Other smoke particles include **soot** (unburned carbon) and **ash** (unburnable minerals). Most smoke particles average less than one micron (one millionth of a meter) in size, allowing them to remain airborne for weeks. When inhaled, they travel easily deep into the lungs, **causing irritation and coughing. Smoke PM10 particles may be trapped in your lungs for years, contributing to lung changes, chronic lung diseases, and cancer.**

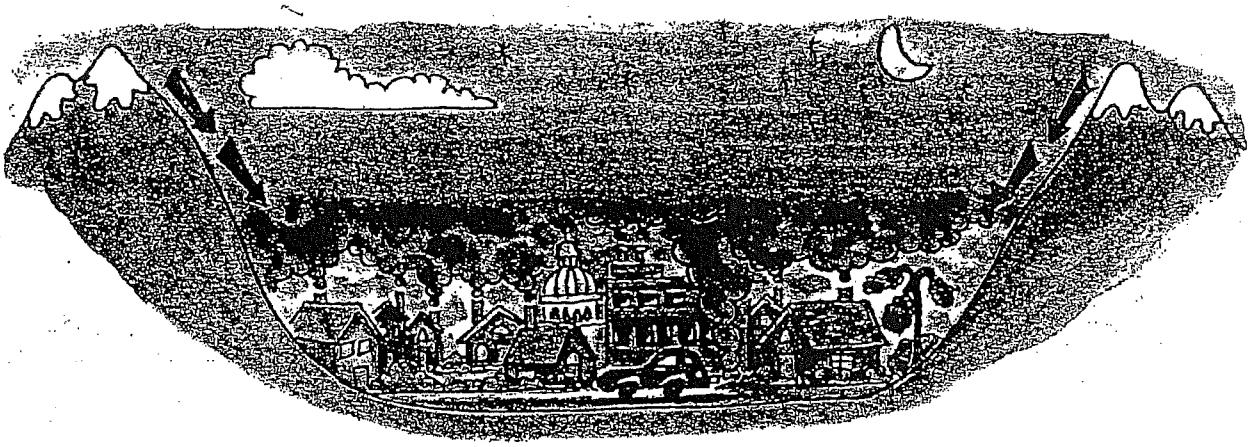
Smoke Contains Toxic Pollutants

Woodsmoke also contains VOCs which have been changed in the fire into **irritating, toxic and/or cancer-causing substances such as benzene, formaldehyde and benzo-a-pyrene, a polycyclic aromatic hydrocarbon (PAH).** Researchers are now studying these and other smoke products to learn more about their effects on human health.

Smoke Hangs Around in Winter...

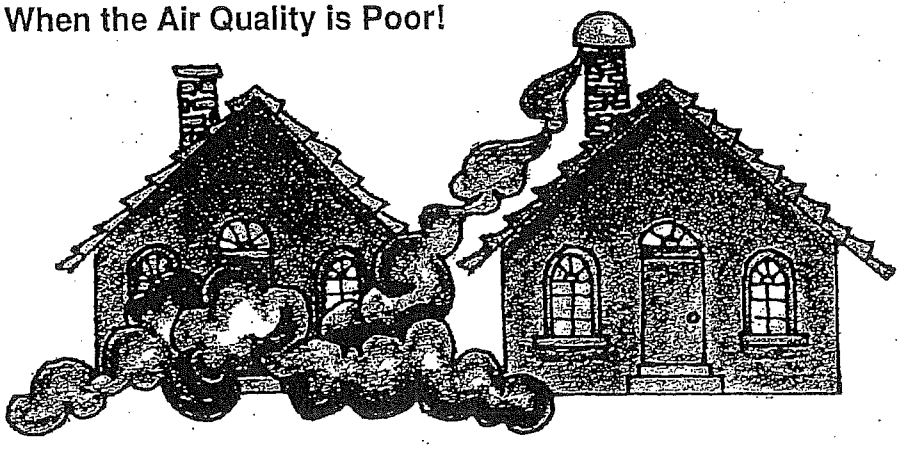
Cold nights, with little wind - common weather conditions in winter months when we heat our homes - often cause smoke and other air pollution to accumulate close to the ground overnight. These stagnant conditions can last for days.

This is a big problem in valleys. As night falls, ground level air cools and cold air also slides down the valley walls, pooling on the valley floors. With little or no wind **temperature inversions** can then occur - warm air layers act as a lid over the cold air in the valleys, trapping smoke and other air pollution close to the ground. And, as home heating systems operate mainly in the evening, **the smoke from stoves and fireplaces remains at ground level and collects overnight in the air you and your neighbors must breathe. Yes, it <u>does</u> seep into your homes.**



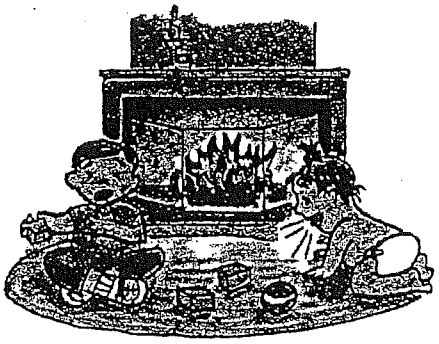
Don't Smoke Your Neighbors Out!

Smoke from neighborhood stoves and fireplaces is a common source of both odor and reduced visibility, the air pollution problems that people complain about the most. These, plus the health-related problems caused by inhaling smoke pollutants, add up to significant health and welfare costs for individuals and the community. So be a good neighbor and limit your burning, and if you do burn, burn correctly. **But Do Not Burn Wood When the Air Quality is Poor!**



Burning Wood Often Causes Indoor Air Pollution

High levels of smoke pollutants leaking from stoves and fireplaces have been measured in some woodburning homes. If you or a family member suffer from chronic or repeated respiratory problems or heart disease, you should not burn wood at all. If you must burn, make sure your stove or fireplace doesn't leak and that you operate it correctly. **Remember, if you can smell smoke, you have a problem.**

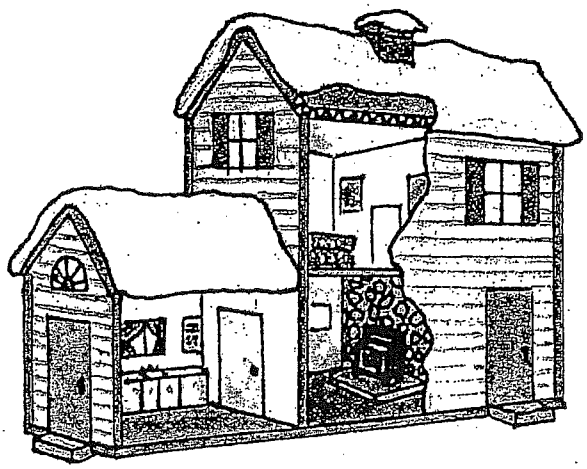


Where Does Your Heat Go?
The Importance of Insulation and Weather-stripping

Heated air is always escaping from your house, and is replaced by unheated outdoor air. The typical house has one-half to two air exchanges per hour, and more on windy and/or very cold days. If your house has little insulation and many air leaks, you are paying to heat the outdoors. **And if the outside air is smoky, soon your air inside will be, too.**

Some air exchange is necessary because of the many sources of air pollution in the home (wood heater, gas stove, consumer products, cigarettes, etc.) And sufficient fresh air inlets are needed to replace air forced out of the house by exhaust fans, the dryer, furnace, water heater, or wood fire; or "backdrafting" will suck polluted exhaust air in the appliance vents back into the home. **But you can reduce your heating needs if you:**

Install Ceiling Insulation (Very Important) - because hot air rises, **much heat is lost** through the ceiling and roof. Wall and floor insulation also reduce heat loss. Recommended amounts have increased in recent years, so be sure your house has all it needs.



Caulk around all windows, doors, pipes, **any** opening into the house.

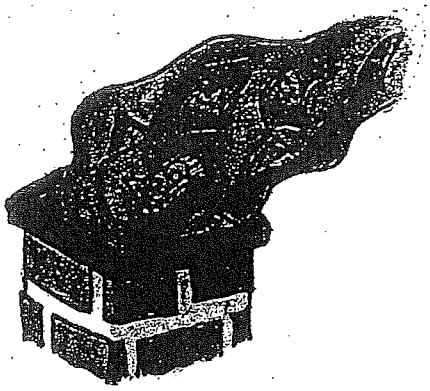
Weather-strip all door and window openings, and consider installing double-paned glass, outdoor or indoor storm windows, and/or insulated curtains.

Close the damper tightly when the heater is not in use. Stoves and fireplaces allow air to leak out of the house even when they are not operating, unless they are **literally** airtight.

Close off unused rooms if you don't use central heating - don't waste the heat.

Thermal Storage can help you keep your heat longer. Brick, stone or water-filled structures located near the heater soak up heat from a fire (and from sunlight!) and release it back into the room for hours after the fire is out.

Most Fireplaces and Old Woodstoves Are Expensive Heaters Because They Turn a Large Part of Your Firewood Into Smoke, Not Heat!



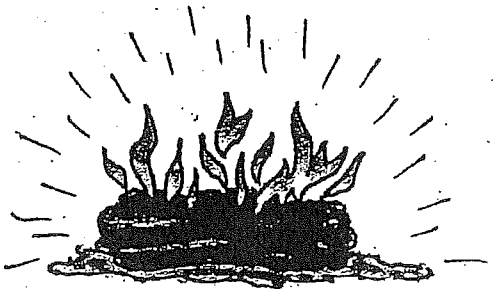
Why Does This Happen? Because of the Way Wood Burns -

Wood burns **completely** only at **very high temperatures** with enough **oxygen** present. The fuel, heat, and oxygen have to mix together in the same place at the same time. Although all stages of burning actually occur at the same time on a burning log, let's place a "demonstration" log on a hot fire. As temperature rises, it will "burn" in three stages:

1. Boil Off Water - moisture in the log evaporates as it heats up, and hisses and bubbles out through the log's surface as water vapor. This takes longer and **uses up lots more heat energy** if the log isn't really dry. *That heat energy could be warming your house instead of drying your wood before it will burn.*

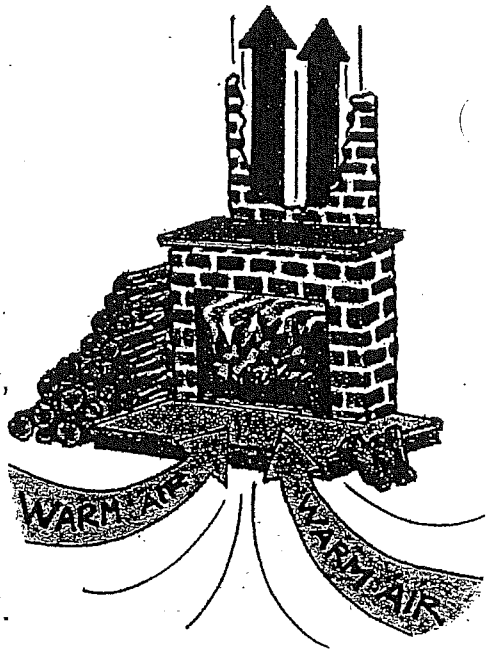
2. Vaporize Wood Gases - before burning, firewood "cooks" and forms hundreds of new volatile organic gases and tars plus charcoal (carbon). The gases and tars, a large part of your fuel, vaporize in the heat and stream out of the log in a "wind" of organic gases. **They escape up the flue** because the log temperature at this stage is too low to burn them. *As they cool, some of the gases will combine with water vapor to form highly flammable* ***creosote*** *that sticks to the flue walls; other gases condense into smoke particles.*

3. Burn Log Charcoal - above 600° F the log "catches fire" and the escaping gases start burning, ignited by nearby flames, but the log charcoal doesn't start to burn and emit heat until the log reaches 1000° F. **Burning the charcoal remainder of the log produces most of the fire's usable heat.** *Most of the log's gases and tars will escape unburned; there's still not enough heat or oxygen this close to the log to burn them. They don't ignite before reaching 1100° F, and then* ***only*** *with enough* ***oxygen*** *present.*



The PM10 pollution from <u>one</u> old woodstove, emitting 60 grams/hour of PM10, equals that of <u>ten</u> EPA certified stoves (averaging 6 grams/hour PM10), or that of <u>three</u> <u>thousand</u> gas furnaces - producing the same amount of heat.

Most Fireplaces Are Not Good Heaters

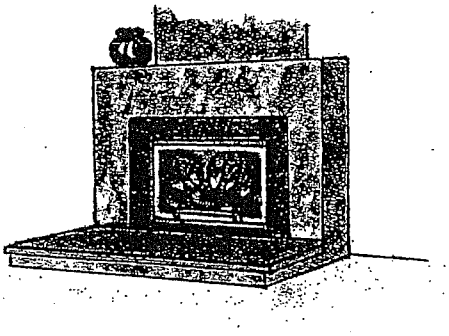


Most fireplaces rob your house of heat because they draw in lots of the air you've paid to heat and send it up the chimney! Yes, you'll be warmed if you sit within six feet of the fire, but the rest of your house is getting **colder** as outdoor air leaks in to replace the hot air going up the chimney.

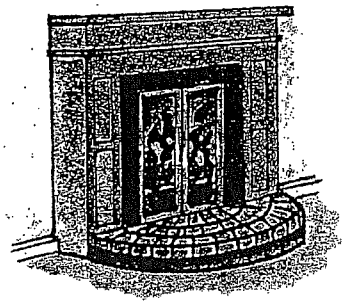
Most fireplaces waste wood because with unrestricted air flow, the vaporized wood gases and tars cooked out of your logs go right up the chimney as **smoke.** And all that air helps the fire **burn fast**, so a load of wood lasts only one or two hours.

Most fireplaces can pollute more if you install glass doors or a fireplace insert that is not a new, certified clean-burning model. Restricting the air supply reduces the available oxygen and causes the fire to smolder and smoke.

You Can Clean Up Your Air Guzzling Fireplace!

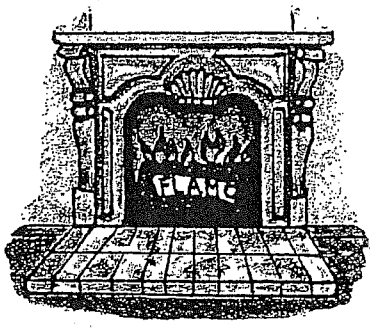


Switch to Gas. Gas fireplaces are gaining in popularity. The new models look like a real wood fire! They are self-contained units which can be fitted into your existing masonry fireplace. They send less of your heated air up the chimney. **This equipment burns cleaner, is easy to start, convenient, safe and inexpensive to operate, and is a good source of heat.**



Certified Woodburning Fireplace Inserts have been developed which meet federal emission standards and provide high fuel efficiency. They are available in many sizes and styles to fit into your masonry fireplace. **They provide excellent fire viewing and heat output with very little smoke.**

Burn Manufactured Fireplace Logs. Reduce heat loss and air pollution from your fireplace by burning **firelogs.** Made of dry, fine-particle sawdust **and wax**, these "logs" burn slowly at high temperatures, producing less smoke and sending less air up the chimney. Underwriters Laboratories (UL) recently classified firelogs as safe to burn in UL listed factory built fireplaces. **Firelogs are not recommended for use in woodstoves, however.**



How Much Heat You Get

The **heating efficiency** of any wood heater depends on combining two factors:
1. **How completely it burns the firewood** (combustion efficiency); plus
2. **How much of the fire's heat gets into the room,** rather than going up the flue (transfer efficiency).

How efficiently <u>your</u> heater operates depends on 2 more factors:
1. **Its installation** - located on an outside wall? Too big for house? Flue draws well?
2. **Its operation** - Wood green? Stove stuffed with wood? Fire starved for air?

<u>Your</u> <u>operating</u> <u>techniques</u> account for the largest variations in your stove's heating efficiency.

HEATING EFFICIENCY	
Masonry Fireplace	-10% to 10%
Manufactured Fireplace	-10% to 10%
Freestanding Fireplace	-10% to 30%
Antique Stove	20% to 40%
Fireplace Insert	35% to 50 %
Airtight Stove	40% to 50%
Masonry Heater	50% to 70%
Certified Stoves, Inserts, Fireplaces	60% to 80%
Gas Heater	60% to 90%
Electric Heater	100%

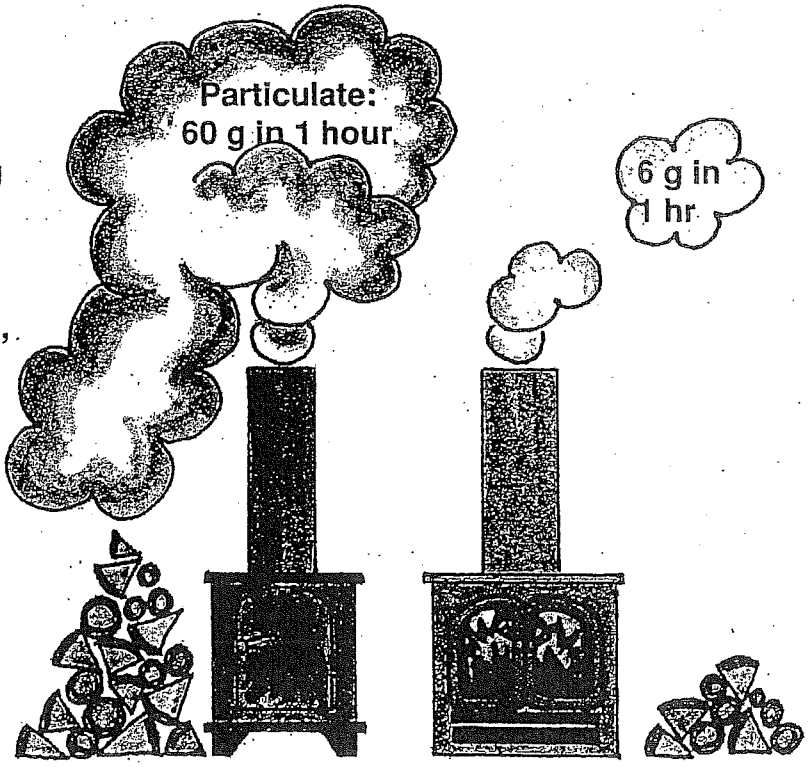
Can't Heat With Gas? Get a New EPA Certified Stove -

Old stoves <u>waste</u> 30% to 60% of your wood. If your woodstove is more than a few years old and is not EPA certified, you should should seriously consider buying a new certified woodstove.

It will burn <u>all</u> of your wood, increasing combustion efficiency, producing far less smoke and creosote buildup, and reducing air pollution.

It incorporates the latest and best technology available on transfer efficiency, and will provide more heat for your house and less for your flue!

Burn two cords instead of three and get the same amount of heat!

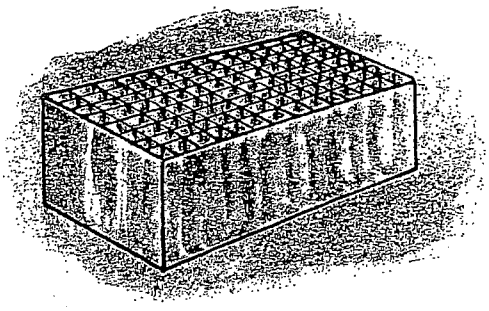


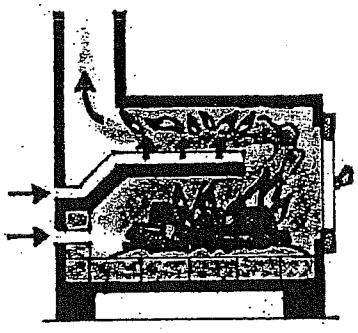
It Will Help Pay For Itself in Fuel and Cleaning Savings!

EPA Certified Woodstoves Heat More and Pollute Less

Since 1988, the manufacture and sale of new woodstoves and fireplace inserts in the US have been regulated by the EPA (Environmental Protection Agency). Tighter standards (Phase II certification) became effective on July 1, 1990. The certified stoves heat better with less wood because **they burn more of the combustible gases that become smoke** in fireplaces and old stoves. There are three basic certified stove designs to choose from:

Catalytic Stoves - similar to the smog device on new cars, the catalytic combustor in these stoves allows the volatile gases to burn at lower temperatures. Smoke passes through a ceramic honeycomb coated with a rare-metal catalyst, which allows complete smoke combustion and heat release at 500-700° F. Their efficiency does drop over time and the catalyst device requires replacement after three to seven years of use.

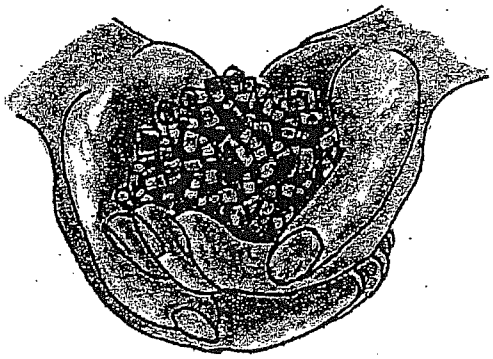




Noncatalytic Stoves - these stoves are designed with baffles and/or secondary combustion chambers which route the burnable gases through the hottest part of the firebox and mix them with sufficient air to burn them more completely.

Pellet Stoves Burn Cleaner Than Cordwood Stoves

The most efficient and least polluting of the new stove designs, most are exempt from certification because they provide excess combustion air. Most have some moving parts and require electricity. The pelleted fuel (compressed wood waste) automatically feeds into the firebox. A fan blows in combustion air and the fire burns hot and clean. Another fan blows room air through a heat exchanger and into the room.



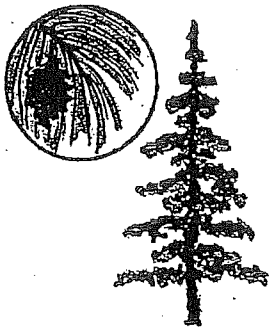
Look for the Permanent EPA Label on the Stove Before You Buy!

For maximum safety and efficiency have a professional installer calculate the correct stove size for the area you want to heat, install the stove, and design and install the chimney.

Follow These Tips on Clean Burning -

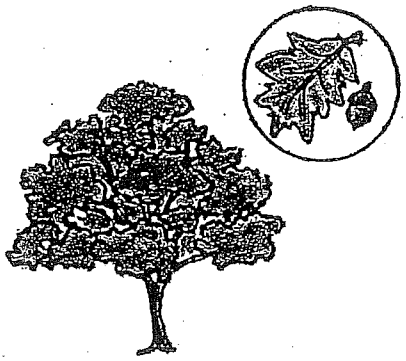
Heat More Efficiently and Reduce Air Pollution!

1. Burn a Mix of Softwoods, Hardwoods, Pressed Logs



Start Your Fire With Softwood Kindling

Softwoods (pine, fir) are generally low in density, ignite easily, burn fast and hot and will heat the firebox and flue quickly. They're ideal for kindling and starting your fires but **form creosote easily** due to the high resin (sap) content.



Burn Longer and Cleaner With Hardwood and/or Manufactured Densified Logs

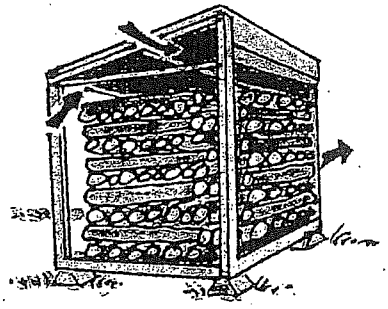
Hardwoods (oak, orchard) are **denser** and take longer to ignite, but burn slower and more evenly, producing less smoke. They also **provide more heat energy** than softwood logs the same size. **Densified logs** are compressed sawdust (no wax); at 8600 Btu/lb, they burn longer and emit 25 to 50% less PM10, CO and VOCs than burning cordwood.

2. Burn Only "Seasoned" Firewood

Firewood should dry, or "season" **6 to 12 months minimum** after splitting. Hardwoods dry slower than softwoods and some may take over a year to dry. "Seasoned" firewood by definition contains 20 per cent moisture or less by weight. **The warmer the storage area, and the more air circulation, the faster the drying time.**

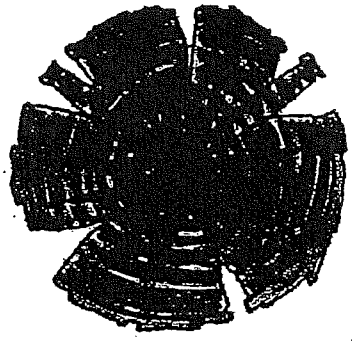
To Speed Drying:

Split and Stack - logs dry from the outside in, so split big logs right away for faster drying. Stack loosely in a **crosswise** fashion to get good air circulation.



Store High & Dry - Stack a foot or more above the ground and away from buildings in a sunny, well-ventilated area. Cover the top to keep dew and rain off the wood, but leave the sides open to breezes.

3. Buy Wood Advertised as "Seasoned" Carefully. Look for:



- **Dark colored, cracked ends,** with cracks radiating from the center like bicycle spokes.
- **Light in weight,** meaning there's little moisture left - but hardwood logs will weigh more than softwood.
- **Sound** - hit two pieces together. Wet wood makes a dull "thud" sound. Dry wood rings with a resonant "crack," like a bat hitting a ball.
- **Easily peeled or broken bark.** No green should show under the bark.

4. Don't Burn Anything but Clean, Seasoned Wood, Manufactured Logs, and Nonglossy White Paper

No Garbage, Plastics, Rubber, Waste Solvent, Paint or Oil, No Painted or Treated Wood, Particleboard, Plywood, or Saltwater Driftwood, No Coal or Charcoal Briquettes, and No Glossy or Colored Paper. **Burning this stuff can produce noxious, corrosive smoke and fumes which may be toxic** and can foul your catalytic combustor, your flue, and the lungs of your family and neighbors. **Warning:** kiln-dried lumber vaporizes too rapidly, causing creosote buildup.

5. Build a Small, HOT Fire First To Preheat the Firebox & Chimney

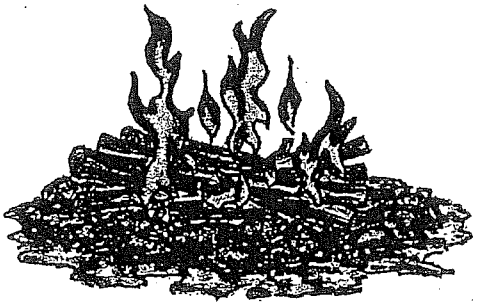
- **Open Damper Wide** - allow in maximum air to fuel the fire. And leave it and other air inlets open for 30 minutes.

- **Start Small & Hot** - leave a **thin** layer of ash for insulation. Crumple a few sheets of newspaper and add some small pieces of kindling, then light. Add bigger kindling a few at a time as the fire grows. Get it burning **briskly** to form a bed of hot coals. Now add 2 or 3 logs.

- **Position the logs you add carefully** - place close enough together to keep each other **hot**, but far apart enough to let sufficient air (**oxygen**) move between them.

Light & Refuel Your Fire Quickly and Carefully , As These Are The Two Times It Will Smoke the Most.

6. Refuel While the Coals Are Still Hot!



Open the draft controls and damper **one minute before** opening the stove door. This helps prevent backpuffing of smoke into the room.

Preheat again by placing a few pieces of kindling on the red hot coals. Add more as they catch fire. Add a **few** larger pieces. **Small, frequent loading smokes less than a big load in most older stoves.**

After refueling, leave the dampers and inlets open for about 30 minutes. The fire will get plenty of air and burn hot, retarding creosote formation (most forms early in a burn). You'll know the chimney is heated again when the new logs burn vigorously.

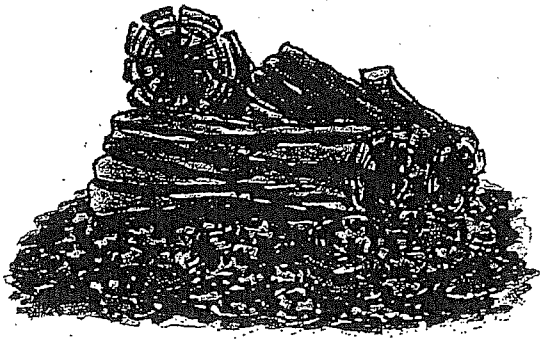
7. Maintain Your Fire Properly - Watch the Temperature

Don't Close the Damper or Air Inlets Too Far - the fire will smoke from lack of air.

Follow the Stove Manufacturer's Instructions Carefully. And be sure that any family member who operates the stove is also familiar with these instructions.

Your Actions Determine How Efficiently Your Stove Will Operate. A good stove is designed to burn cleanly and efficiently, but it can't do its job right if you don't cooperate.

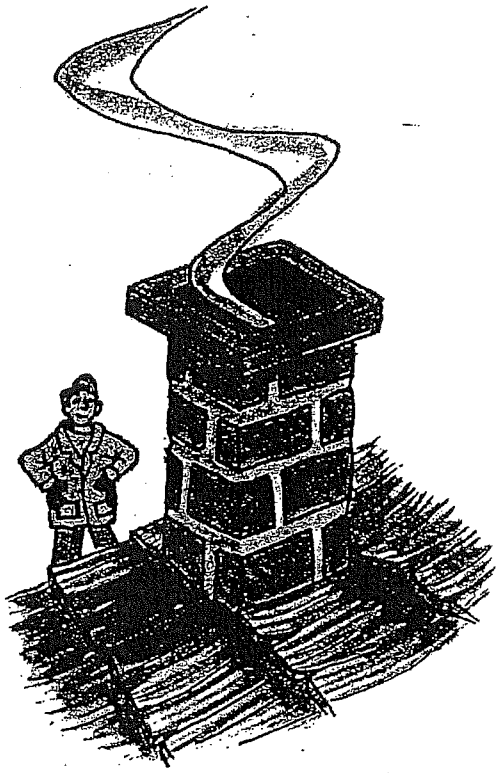
8. Overnight Heating



Best NOT to Burn Overnight - it's a major fire hazard. And it's too tempting to choke the fire for air to slow burning, and then pollute the neighborhood all night. This can also lead to backdrafting the smoke into your own home, causing very hazardous indoor air pollution.

Better to Build a Small, Hot Fire and Let It Burn Out Completely, relying on your home's insulation to hold in enough heat for the night. **Then Close the Damper Tightly.**

9. Heating in Warmer Weather



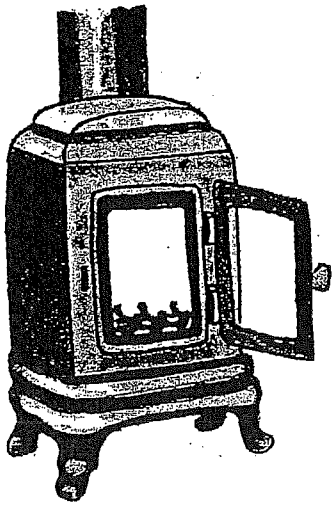
If a small space heater won't suffice, open the air controls wide and build a **small, hot fire**, using more finely split wood, and let it burn out. Trying to reduce the heat from a big fire by reducing its air supply leads to smoldering, creosote buildup and air pollution.

10. Watch for Smoke Signals!

Get into the habit of glancing out at your chimney top every so often. Apart from the half hour after lighting and refueling, a properly burning fire should give off only a thin wisp of white steam. **If you see smoke**, adjust your dampers or air inlets to let in more air. **The darker the smoke, the more pollutants it contains** and the more fuel is being wasted.

11. Inspection and Upkeep - For Safety's Sake

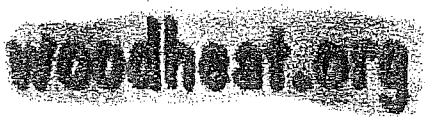
Periodic **inspection** of your stove or fireplace is **essential** to ensuring its continued safe and clean-burning operation. Be sure you carefully check, and repair as needed, the:



- **Chimney Cap** can be plugged by debris which will reduce draft.
- **Chimney** should be cleaned professionally **at least once a year** to remove creosote buildup.
- **Catalytic Combustor** holes can plug up; follow instructions to clean.
- **Stovepipe** angles and bolts are particularly subject to corrosion.
- **Gaskets** on airtight stove doors need replacement every few years.
- **Seams** on stoves sealed with furnace cement may leak. Eventually the cement dries out, becomes brittle, and may fall out.
- **Firebrick** may be broken or missing.
- **Grate** or stove bottom where the fire is built - this may crack or break.

Never Forget That There is a Box With a Fire in it Inside Your House.
And Creosote Can Fuel a Chimney Fire That'll Burn Your House Down.

Visitors often ask these questions.
Our answers are always the same.



The Wood Heat Organization:
Answers to your questions about burning wood for heat and enjoyment.

Frequently asked questions

"Is ? ? ? species of firewood unsafe or unsuitable to burn? A friend told me it would produce a lot of creosote or burn too hot."

It seems like almost every species of wood has been tagged as unsuitable by someone. This is our response:

A few species of wood can produce dangerous emissions and most of them have dangerous sounding names, like poison sumac (swamp sumac), poison dogwood, poison elderberry, poison elder, poison oak. The smoke can contain the same compounds that cause allergic reactions on skin, but when airborne can cause respiratory distress if inhaled.

Aside from these few examples, we don't consider any normal species of wood dangerous or inappropriate for burning based on the idea that they produce much more creosote. There are woods with sticky sap in their bark and others that can't be split by hand and so are not as desirable as others. But creosote is a product of combustion, not a component of wood. If burned in bright, hot fires, much less creosote is formed from whatever wood is burned. This includes the pitchy bark of pine and spruce and the volatile bark of white (paper) birch.

Our advice is to try whatever firewood you have available. Make sure the wood is properly seasoned because all wood species burn poorly and produce smoky fires if their moisture content is too high. Extremely dry wood, like kiln-dried lumber, can also produce smoky fires. If you have some very dry wood available, mix it with regular firewood to avoid excessive smoke.

Burn bright, hot fires. Don't let your fires smolder.

We burn a lot of wood that others might consider junk. But maybe junk wood is the most environmentally suitable type to burn because it is useless for any other purpose. In our view, aside from the few poisonous species, no wood species is junk unless it has been painted, treated or is salt-laden from being in the ocean.

A clean burning wood fire is much more interesting and dramatic to watch than a conventional smoky fire.

woodheat.org

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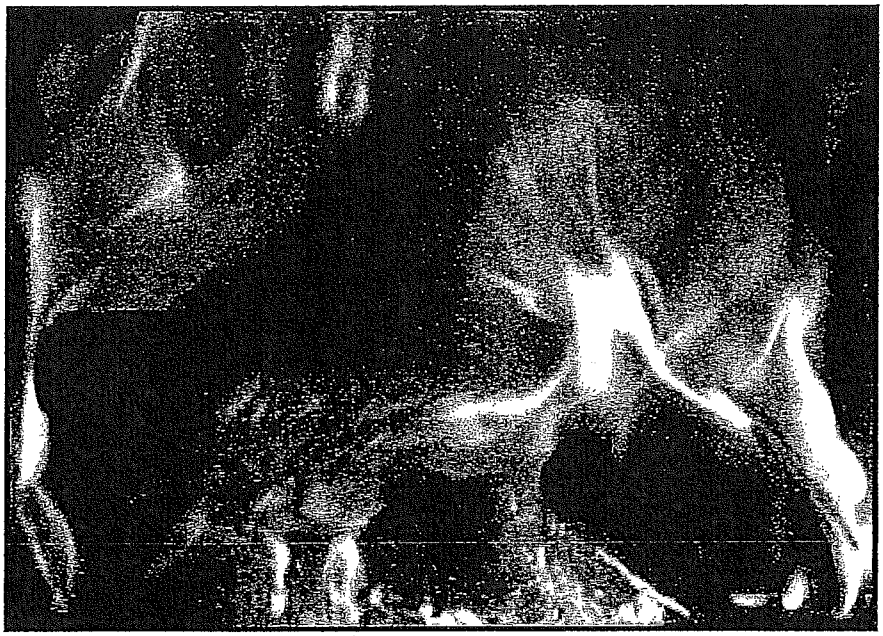
This is what a clean burning fire looks like



This is a photo through the glass of an advanced technology wood stove, one that is EPA certified. Note that the flames are big and lush and semi-transparent, much different from the dark, opaque, ragged flames you would see in an open fireplace. The small jets and feathery flames at the top of the image are flowing downward from the tiny combustion air holes at the top of the firebox.

Not only do these stoves burn much cleaner and more efficiently than older conventional stoves, but the view of the fire is just spectacular, well worth the price of admission. Those of us who study woodburning for a living claim it is the best looking fire in the world. By upgrading to one of these stoves, you can save wood, reduce smoke and enjoy the view all winter long.

WOOD HEAT HOME