WOOD BURNING HANDBOOK

Protecting the Environment and Saving Money

Alternatives to Burning Wood

Reducing Wood Smoke Pollution

Getting More Heat For Your Fuel Dollar

Cal/EPA Air Resources Board
Enforcement Division
Compliance Assistance Program

In Cooperation with Local Air Pollution Control Districts

Burning Wood Produces Wood Smoke and Air Pollution!

The California Environmental Protection Agency and your local air district are asking you to help clear the air of wood smoke. In this handbook you will find information about the air pollutants in wood smoke, health effects of smoke, how wood burns, why it smokes, and how you can reduce wood smoke pollution.

Smoke from neighborhood stoves and fireplaces, a common source of both odor and reduced visibility, greatly contributes to the air pollution problems people complain about most. When you include the health-related problems caused by inhaling smoke pollutants, health costs for individuals and the community can be significant. To be a good neighbor, eliminate wood burning. If you do burn, learn to limit the amount of wood smoke produced.

Sources of Wood Burning and Air Pollution…

Air pollution affects millions of Californians every day. It damages our health, our crops, our property and our environment. In neighborhoods everywhere across California, residential wood burning is a growing source of air pollution. Most wood heaters, such as woodstoves and fireplaces, release far more air pollution, indoors and out, than heaters using other fuels. In winter, when we heat our homes the most, cold nights with little wind cause smoke and air pollutants to remain stagnate at ground level for long periods.

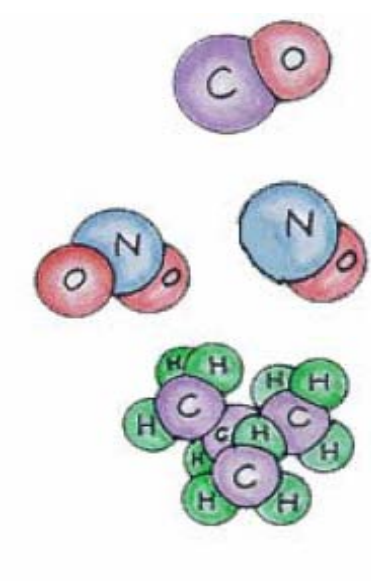
Burning Wood Causes Indoor Air Pollution

High levels of smoke pollutants leaking from stoves and fireplaces have been measured in some wood burning homes. If you or family members suffer from chronic or repeated respiratory problems like asthma or emphysema, or have heart disease, you should not burn wood at all. If you must burn wood, make sure your stove or fireplace doesn't leak and that you operate it correctly.

Remember - If you can smell smoke, you are breathing smoke!

What Happens when Wood Burns?

Complete combustion gives off light, heat, and the gases carbon dioxide and water vapor. Because when wood burns complete combustion does not occur. It also produces wood smoke, which contains the following major air pollutants, regulated by State and federal rules because of their known health effects:



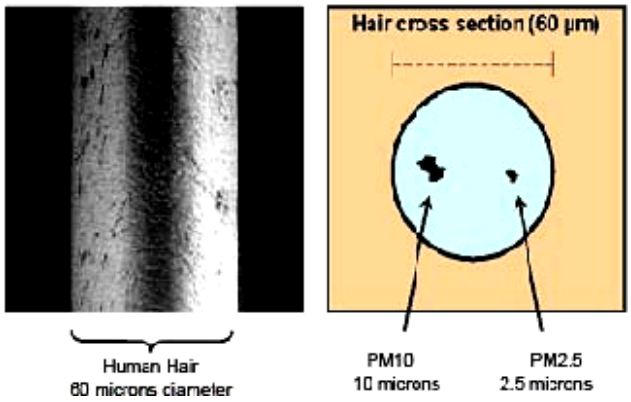
Carbon Monoxide (CO) – An odorless, colorless gas, produced in large amounts by burning wood with insufficient air. CO reduces the blood's ability to supply oxygen to body tissues, and can cause stress on your heart and reduce your ability to exercise. Exposure to CO can cause long-term health problems, dizziness, confusion, severe headache, unconsciousness, and even death. Those most at risk from CO poisoning are the unborn child, and people with anemia, heart, circulatory, or lung disease.

Oxides of Nitrogen (NOx) – NOx impairs the respiratory system and its ability to fight infection. NOx also combines with VOCs to make ozone and with water vapor to form acid rain or acid fog.

Volatile Organic Compounds (VOCs) – Evaporated carbon compounds which react with NOx in sunlight to form ozone (photochemical smog). Ozone injures the lungs and makes breathing difficult, especially in children and exercising adults. NOx and VOCs also form particulate matter through reactions in the atmosphere.

Toxic Pollutants – Wood smoke also contains VOCs which include toxic and/or cancer-causing substances, such as benzene, formaldehyde and benzo-a-pyrene, a polycyclic aromatic hydrocarbon (PAH). Manufactured fireplace logs, for instance, are not recommended for burning because they produce toxic fumes, including PCBs (polychlorinated biphenyls). Researchers are now studying these and other smoke products to learn more about their effects on human health.

Relative Size of Particulate Matter



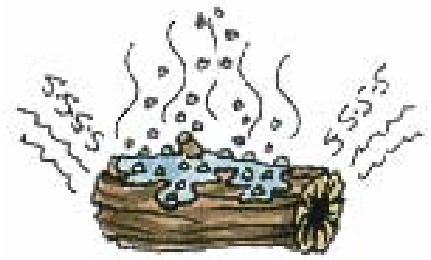
Particulate Matter less than 10 microns in diameter (PM10) are very small droplets of condensed organic vapors of wood tar and gases. These particles are a result of unburned fuel and have a diameter of 10 microns or smaller (the diameter of a human hair is about 50 to 100 microns), which allows them to be inhaled into the lungs. Exposure to PM10 aggravates a number of respiratory illnesses.

PM10 includes a smaller group of particles called **PM2.5**, particles with diameters of 2.5 microns and less. These finer particles pose an increased health risk because they can lodge deep in the lungs and contain substances that are particularly harmful to human health, contributing to lung diseases and cancer. Exposure to PM2.5 may even cause early death in people with existing heart and lung disease.

Fireplaces and Old Woodstoves Are Inefficient, Expensive Heaters!

Why…Because of the Way Wood Burns -

As the fire temperature rises, different stages occur:



Stage 1 – Water Boils Off

As the log heats, moisture contained in the log vaporizes, and escapes through the log's surface as water vapor. More energy is used up vaporizing the moisture than is used to burn the log. That heat energy could be warming your house instead of drying your wood before it burns.

Stage 2 - Vaporizes Wood Gases

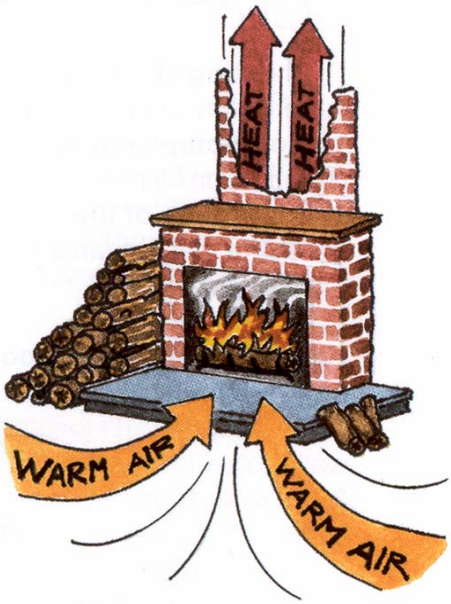
Before burning, firewood "cooking" creates and releases hundreds of new volatile organic gases, which contain VOCs, tars and charcoal or carbon. Because the log temperature at this stage is too low to burn gases and tars, they escape up the flue. As they cool, some of the gases will combine with water vapor to form highly flammable **creosote** that sticks to the flue walls; other gases condense into smoke particles.

Stage 3 - Log Charcoal Burns

At temperatures above 600 degrees Fahrenheit the escaping gases start burning, ignited by flames. As the temperature reaches 1000 degrees, the charcoal log burns and emits heat. Burning the charcoal produces most of the fire's usable heat.

As you can see, most of your investment in wood goes up in smoke. This is an expensive way to produce a little heat!

Most Fireplaces are Not Good Heaters!



Most fireplaces rob your house of heat because they draw air from the room 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.

The key to burning clean and hot is to control the airflow. Most fireplaces waste wood because of unrestricted airflow. A lot of air helps the fire burn fast, but a load of wood will last only one or two hours.

Some older fireplaces actually pollute more if you install glass doors on an old fireplace insert that is not a certified clean-burning model. Restricting the air supply causes the fire to smolder and smoke. Make sure you install a new, certified clean-burning fireplace insert.

Where Does Your Heat Go? Check your Insulation and Weather-Stripping

Warm 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.) Sufficient fresh air inlets are needed to replace air forced out of the house by exhaust fans, dryers, furnaces, water heaters, or wood fires. Here are some suggestions to minimize excess air exchange:

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

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

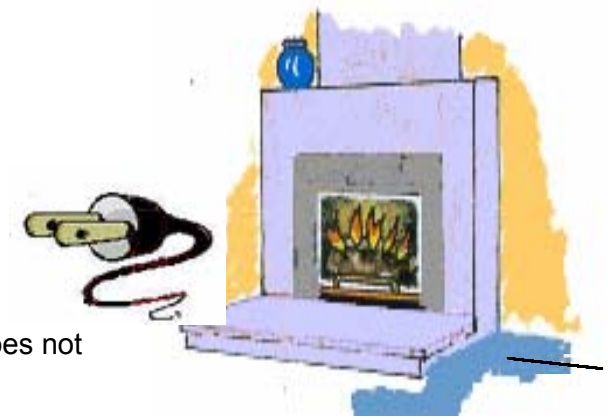
Weather-strip all door and window openings. Consider installing double-paned glass, outdoor or indoor storm windows, and/or insulated curtains.

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 do not use central heating – Don't waste the heat!

Clean up your Air Guzzling Fireplace by Trying Alternate Heating Methods…

Use an Electric Fireplace



Electric fireplaces can be installed anywhere, and no vent is required. They can be plugged into any standard household electrical (120V) outlet and can operate with or without heat. Most fireplaces are made with an adjustable thermostat that maintains room temperatures. The fireplace glass does not absorb heat, so is safe to touch whether or not the heater is operating.

Switch to Gas

Gas fireplaces are very popular and look like a real wood fire! They are self-contained units, which can be fitted into your existing (vented) 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. Gas fireplaces are also a good choice if you're remodeling a home and replacing a wood fireplace.

Try a Pellet Stove

Pellet stoves are the most efficient and least polluting of the new stove designs. Most are exempt from certification because they provide less than 1 gram per hour of particulate emissions. Usually these stoves have some moving parts and require electricity. The fuel, which is made from compressed wood waste and formed into pellets, automatically feeds into the firebox. Combustion air is drawn in and the fire burns hot and clean. Another fan blows room air through a heat exchanger and into the room.

Install a Certified Wood Burning Fireplace Insert

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. (Note: The use of a fireplace insert in manufactured homes is regulated and subject to inspection by the California Department of Housing and Community Development. For more information see 24cfr3280.709 of the CFR.)

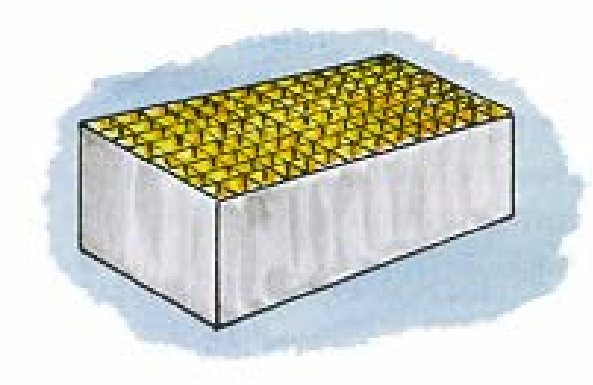
U.S. EPA Certified Wood Stoves

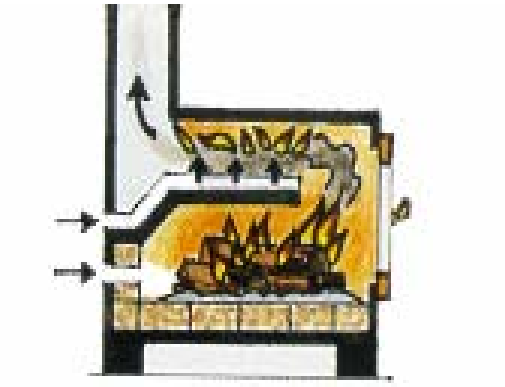
U.S. EPA Certified Wood Stoves Heat More and Pollute Less

U.S. EPA requires wood stove manufacturers to conduct a quality assurance program for wood heaters. Wood heaters must be certified. A permanent label on a wood heater indicates that it meets the emission standards. A consumer information label is also required that specifies the emission rate, the heating range of the wood heater, and overall efficiency. Certified stoves heat better with less wood because they burn more of the combustible gases that would otherwise become smoke in fireplaces and old stoves. There are two types of certified wood stove designs to choose from:

Catalytic Stoves

Similar to the smog control 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 only 500-700 degrees F. Their efficiency does drop over time and the catalyst device requires replacement after three to seven years of use.





Non-Catalytic 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. They can attain up to four stages of combustion and completely burn the wood smoke before it escapes.

If your woodstove is not U.S.EPA certified, you should consider buying a new certified woodstove. A new U.S. EPA certified stove will increase combustion efficiency, produce far less smoke and creosote buildup, and reduce air pollution. It uses the latest and best technology available on transfer efficiency, and will provide more heat for your house and less for your flue. If you want to pollute less and save money on fuel, you should insist on an EPA Certified device, which will be clearly labeled as such.

For a list of U.S. EPA certified stoves see:

http://www.epa.gov/Compliance/resources/publications/monitoring/caa/woodstoves/certifiedwood.pdf

U.S. EPA Certified Wood Stoves Release Fewer Particulate Emissions

Because of incomplete combustion, old wood stoves can produce up to 50 grams of particulate per hour. EPA Certified fireplace inserts and EPA Certified wood stoves are considerably more efficient, producing only 6 grams per hour. EPA Certified devices create the right conditions for complete combustion; the right amount of air, high temperature, and time to allow the gases to fully burn.

Check How Much Heat You Get...

The heating efficiency of any wood heater depends on combining two factors:

- How completely it burns the firewood (combustion efficiency), and
- How much of the fire's heat gets into the room, rather than going up the flue (transfer efficiency).

How efficiently your wood heater operates depends on 2 more factors:

- Installation – is it located on an outside wall? Too big for house? Flue draws well?
- Operation – Is the wood green? Is the stove stuffed with wood? Is the fire starved for air?

Your operating techniques account for the largest variations in your woodstove'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%
Certified Stoves, Inserts, Fireplaces	60% to 80%
Gas Heater	60% to 90%
Pellet Stove	75% to 90%
Electric Fireplace	100%

Look for the Permanent U.S.EPA Label on Certified Devices!

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

If You Still Must Burn Wood, Follow These Tips on Clean Burning – To Heat More Efficiently <u>and</u> Reduce Air Pollution!

➢ 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 are ideal for kindling and starting your fires, but form creosote easily due to the high resin (sap) content.

➢ Burn Longer and Cleaner With Hardwood

Hardwoods (oak, cherry) 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 of the same size.

➢ Burn Only "Seasoned" Firewood

Firewood should dry, or "season" a minimum of 6 to 12 months after splitting. Hardwoods dry more slowly than softwoods and may take over a year to dry. Seasoned firewood by definition contains 20 percent moisture or less by weight. Wood dries faster in a warmer storage area with more air circulation.

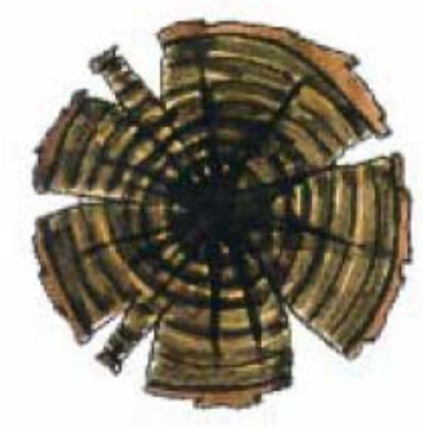
➢ To Speed Dry:

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

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

➢ Be Careful when Buying Wood Advertised as "Seasoned". *Look for*:

- **Dark colored, cracked ends**, with cracks radiating from the center like bicycle spokes.
- **Light in weight,** meaning there is little moisture left; 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 baseball.
- **Easily peeled or broken bark**. No green should show under the bark.



Build a Small, HOT Fire First…

- **Open Damper Wide** - allow in maximum air to fuel the fire. And leave it and other air inlets open for 30 minutes.
- **Start Small and 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 next logs carefully** - place logs close enough together to keep each other hot, but far apart enough to let sufficient air (oxygen) move between them.

Refuel While the Coals Are Still Hot!

If a fireplace insert or glass door is present, open it slightly for a minute to prevent back puffing of smoke into the room. When smoke subsides, then open the door fully.

Preheat again by placing a few pieces of kindling onto the red-hot coals. Add more as they catch fire, then add a few larger pieces. Small, frequent loading causes less smoke 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 (which forms early in a burn).

Light & Refuel your fire quickly and carefully.
These are the times it will smoke the most.

➢ Don't Burn Anything but Clean, Seasoned Wood, Fireplace Logs, and Non-glossy White Paper

- ***No* Garbage**
- ***No* Rubber**
- ***No* Particleboard**
- ***No* Glossy Paper**
- ***No* Solvent or Paint**
- ***No* Coal or Charcoal**
- ***No* Plastics**
- ***No* Waste**
- ***No* Plywood**
- ***No* Colored Paper**
- ***No* Oil**
- ***No* Painted / Treated Wood**

Burning these materials can produce noxious, corrosive smoke and fumes that may be toxic. They can foul your catalytic combustor, your flue, and the lungs of your family and neighbors.

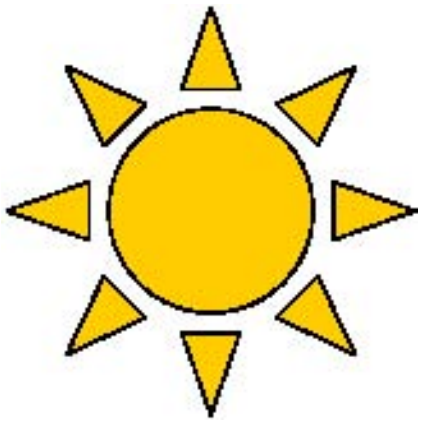
Warning: Kiln-Dried Lumber vaporizes too rapidly, causing creosote buildup.

Overnight Heating

When using an open fireplace, DO NOT burn overnight unattended - it's a major fire hazard. This can also lead to a back draft of the smoke into your own home, causing very hazardous indoor air pollution.

Build a small, hot fire and let it burn out completely. Rely on your home's insulation to hold in enough heat for the night. When the fire is out, close the damper tightly.

➢ Heating in Warmer Weather



If you do need extra heat in warmer weather, and a small space heater will not suffice, open the air controls wide, build a small, hot fire, using more finely split wood, and let it burn out.
DO NOT try to reduce the heat from a big fire by reducing its air supply because this leads to smoldering, creosote buildup and air pollution.

➢ Maintain Your Fire Properly – Watch the Temperature

- **Do Not Close the Damper or Air Inlets Too Tightly -** The fire will smoke from lack of air.

- **Follow the Wood Stove or Fireplace Manufacturer's Instructions Carefully -** Be sure that anyone who operates it is also familiar with these instructions.

- **Your Actions Determine How Efficiently Your Fireplace or Wood Stove Will Operate -** A good wood stove/fireplace is designed to burn cleanly and efficiently, but it can not do its job right if you do not cooperate.

➢ 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.

➢ Inspection and Upkeep - For Safety's Sake

Periodic inspection of your wood stove or fireplace is essential to ensuring its continued safe and clean-burning operation. Keep in mind the following points when performing your fireplace inspection:

- **Chimney Caps** can be plugged by debris, which will reduce draft.

- **Chimneys** should be cleaned professionally at least once a year to remove creosote buildup. **Remember - Creosote can fuel a chimney fire that can burn down your house!**

- **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.

- **Firebricks** may be broken or missing.

- **Grates** or stove bottoms can crack or break.

Local Wood Burning Regulations

In light of growing evidence of health effects, the smell of wood smoke no longer has the pleasant associations it once had. Some air districts enacted rules to limit the growing wood smoke problem. The following air pollution control districts have specific wood burning rules, regulations and/or ordinances:

Bay Area AQMD, Regulation 6, Rule 3, Wood Burning Devices, http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/reg%2006/rg0603.ashx

Butte County AQMD, Rule 208, Mandatory Wood Burning Curtailment Periods, http://www.bcaqmd.org/page/woodstoves-and-fireplaces.php?hilite=rule,207

Eastern Kern County APCD, Rule 416.1, Wood Burning Heaters and Wood-Burning Fireplaces, http://www.kernair.org/Rule%20Book/4%20Prohibitions/416_1%20Wood%20Burning%20Heaters%20and%20Fireplaces.pdf

Feather River AQMD, Rule 3.17, Wood Heating Devices, http://www.fraqmd.org/Rules/3_17%20Wood%20Burning%20Appliances%202009/RULE%203_17%20final.pdf

Glenn County APCD, Section 99.2, Fireplace and Solid Fuel Heating Device Usage, http://www.arb.ca.gov/drdb/GLE/curhtml/art-IV.htm#SECTION%2099.2

Great Basin Unified APCD, Rule 431, Particulate Emissions–Town of Mammoth Lakes, http://www.arb.ca.gov/pm/pmmeasures/ceffect/rules/gbuapcd_431.htm

Mendocino County AQMD, Regulation 4.1, Particulate Emissions Reduction Measure for Wood Burning Appliances, http://www.arb.ca.gov/drdb/men/curhtml/reg4-r1.pdf

Monterey Bay Unified APCD, Rule 1009, Burning of Treated Wood, http://www.arb.ca.gov/DRDB/MBU/CURHTML/R1009.PDF

Northern Sonoma County APCD, Rule 4-100, Control Measure for Wood Fired Appliance Emissions

Placer County APCD, Rule 225, Wood Burning Appliances, http://www.placer.ca.gov/Departments/Air/~/media/apc/documents/Rules/Reg%202/Rule225WoodBurningAppliances.ashx

Sacramento Metropolitan AQMD, Rule 417, Wood Burning Appliances, http://www.arb.ca.gov/DRDB/SAC/CURHTML/R417.PDF

San Joaquin Valley APCD, Rule 4901, Wood Burning Fireplaces and Wood Burning Heaters, http://www.valleyair.org/rules/currntrules/r4901.pdf

San Luis Obispo County APCD, Rule 504, Residential Wood Combustion, http://www.arb.ca.gov/DRDB/SLO/CURHTML/R504.htm

Shasta County AQMD, Rule 3:23, Fireplace and Solid Fuel Heating Device Usage, http://www.arb.ca.gov/DRDB/SHA/CURHTML/R3-23.HTM

South Coast AQMD, Rule 445, Wood Burning Devices, http://www.aqmd.gov/rules/reg/reg04/r445.pdf

Tehama County APCD, Rule 4:27, Fireplace and Solid Fuel Heating Device Usage, http://www.arb.ca.gov/drdb/teh/curhtml/r4-27.htm

Yolo-Solano AQMD, Rule 2.40, Wood Burning Appliances, http://www.arb.ca.gov/DRDB/YS/CURHTML/R2-40.PDF

Your state and local air pollution control agencies urge you to burn clean, burn safe, and burn smart. Remember…

Choose Not to Burn When Air Quality is Already Poor.

For more information, contact your local building inspector, fire department, county agricultural extension office, woodstove retailer, chimneysweep, or air pollution control district office. For additional information on how to reduce wood smoke in your community, review the US EPA publication, "Strategies for Reducing Wood Smoke". It can be found at: http://www.epa.gov/burnwise/pdfs/StrategiesDoc8-11-09.pdf

Need More Information?

Air Resources Board (800) 952-5588 **District: _____**

Multi-County Districts

Bay Area (415) 749-4999

Feather River (530) 634-7659

Great Basin (760) 872-8211

Monterey Bay (831) 647-9411

North Coast (707) 443-3093

Northern Sierra (530) 274-9360

San Joaquin Valley (559) 230-6000

South Coast (909) 396-2000

Yolo-Solano (530) 757-3650

County Districts

Amador (209) 257-0112

Antelope Valley (661) 723-8070

Butte (530) 891-2882

Calaveras (209) 754-6504

Colusa (530) 458-0590

Eastern Kern (661) 862-5250

El Dorado (530) 621-6662

Glenn (530) 934-6500

Imperial (760) 482-4606

Lake (707) 263-7000

Lassen (530) 251-8110

Mariposa (209) 966-2220

Mendocino (707) 463-4354

Modoc (530) 233-5522

Mojave Desert (760) 245-1661

No. Sonoma (707) 433-5911

Placer (530) 745-2330

Sacramento (916) 874-4800

San Diego (858) 586-2600

San Luis Obispo (805) 781-5912

Santa Barbara (805) 961-8800

Shasta (530) 225-5674

Siskiyou (530) 841-4029

Tehama (530) 527-3717

Tuolumne (209) 533-5693

Ventura (805) 645-1400

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Air Resources Board

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