HELPFUL HINTS
IN HOME HEATING WITH WOOD

This booklet is a project of the North Cal-Neva RC&D Woodland Committee.
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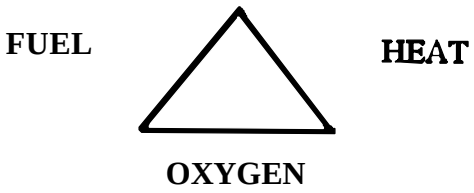
INTRODUCTION

Numerous home fires occur each year from heating with wood. The purpose of this booklet is to help reduce these losses by providing information on the proper installation, operation and maintenance of modern wood stoves, chimneys and flues. Please take a few minutes to review these pages.

HOW WOOD BURNS AND TEMPERATURES EVOLVE

For wood to burn, there are three essential ingredients: heat, fuel and oxygen. The fire triangle illustrates this principle:



Eliminate any one of the above from the triangle and combustion will cease. With proper amounts of each, a fire will burn well.

When wood burns, it goes through three stages:

1. Evaporation - the driving out of moisture.

2. Pyrolysis - at temperatures of 500 degrees Fahrenheit to 1100 ^{o}F wood actually begins to burn with the release of volatile gases and liquids. These gases will burn with increased temperature and in the presence of adequate oxygen. About 40-60% of the heat produced is from the combustion of these gases and liquids. If temperature or oxygen is inadequate, creosote is produced.

3. Charcoal burning - at temperatures above 1100 ^{o}F charcoal is consumed with heat being released more evenly and slower than in the previous stage.

SUCH HIGH TEMPERATURES CAN BE DANGEROUS IF A WOOD STOVE IS NOT PROPERLY INSTALLED OR KEPT CLEANED.

HOME SAFETY WITH WOOD HEATING

CAUSES OF HOME FIRES:

INSUFFICIENT CLEARANCE - Wood or other flammable materials that are repeatedly over-heated become charred. This charred wood can ignite at a temperature as low as 250 ^{o}F. Charring occurs where there has been insufficient stove or chimney clearance. Large nails or screws fastening a heat shield to the wall can transfer heat to the wood beneath, resulting in charring and a fire. Leaving flammable materials too close to a stove, such as drying clothing, also have resulted in home fires.

CREOSOTE BUILD-UP - Creosote results from incomplete burning, as indicated by a "smoky" fire. This is a tar-like substance that coats the walls of a stove or chimney and can readily ignite, causing a "flue fire." This is a rapidly spreading fire running up the chimney, often coming out the top as a shower of sparks and flame. Internal temperatures can easily reach 2000 ^{o}F, resulting in rapid heat penetration of supporting walls and attic. Charring and ignition can result in hidden spaces of the ceiling, attic or roof. In brick and mortar chimneys, the mortar will crack and fall out. Cracks can extend out into the attic allowing flame to ignite wood supports. In metal flues that are not properly screwed together, vibrations can cause the pipes to separate allowing fire into the house. Flaming creosote chunks can be carried by the draft out of the chimney and ignite the roof. Any flue fire is serious and all spaces and the roof should be immediately checked for any possible fire. The local fire department should always be notified.

IMPROPER HANDLING OF ASHES - Cleaning out the stove is an important maintenance requirement but the ashes must be disposed of properly. ALWAYS ASSUME THE ASHES ARE HOT. Always use a metal scoop shovel and a metal bucket. Never use a cardboard box nor store near the house or other flammable material. Use a metal ash can and stir the ashes to ensure that they are out. Remember, ashes are self-insulating and can retain heat for several days. It is illegal to dump hot ashes at any landfill or transfer station.

HOW TO PREVENT HOME FIRES

1. Burn only dry and well-seasoned wood. Never burn quantities of paper, such as Christmas wrapping, or cardboard boxes. This material can quickly rise up the chimney and cause a flue fire. Never burn trash or garbage, especially plastics or aluminum cans.

2. Keep a fire hot enough to prevent creosote accumulation. Check your chimney. If you see heavy smoke, creosote is probably forming. Use only a small amount of wood and re-fill the box several times a day and night. For both heat efficiency and fire safety, a small, hot fire is better than an overloaded, smoldering fire**.**

In using the modern "air-tight" stoves, the stove draft should be opened at least twice a day to allow the fire to produce enough high temperature to dissolve any creosote build-up. The recommended time is 15-30 minutes of full flame. Do not overload the fire box as this impedes air circulation and allows for creosote build-up.

3. Inspect the stove and chimney often to ensure that creosote is not forming. Use a flashlight and check up the firebox or look down the chimney from the roof. Tap the metal flue pipe. A dull sound or the sound of falling "clinkers" indicates serious creosote build-up. Even 1/8 inch thickness of creosote is enough to burn. Also check the flue cap and spark arrestor to ensure proper operation. Many of the local fire departments will make this inspection for you. All you have to do is ask.

4. Clean your stove, flue and chimney regularly. Use a chimney brush that properly fits the flue. Clean at least twice during the burning season and again in spring. Cleaning in spring is important in this country as cool nights are always possible during the summer and a warming fire may be desired. A flue fire in summer can be extremely dangerous because the roof is so dry. When cleaning, always check the system for cracks, damaged parts and proper air flows. Stove' safety features should be tested to ensure proper operation. Immediately repair any defects found. Always refer to your owner's manual.

5. It is recommended that you use stove and chimney thermometers to help monitor your stove's operation efficiency.

PROPER WOOD STOVE INSTALLATION

GENERAL GUIDELINES:

1. New installations should comply with local fire and building codes.

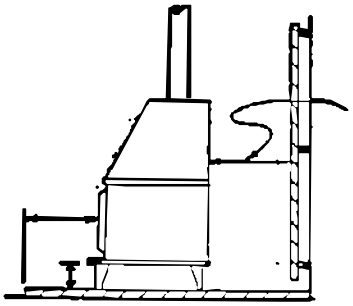
2. Consult with your insurance company before purchasing a wood stove and before installing the stove or flue. They may have special instructions that must be followed before the policy will cover your home.

3. Install only stove or chimney materials approved by the State Fire Marshal or Underwriter's Laboratories (UL listed). Never use home-made stoves.

4. Installations must meet or exceed the manufacturer's instructions and all applicable building and fire codes.

THE WOOD STOVE:

CLEARANCE - This is the most overlooked aspect of fire prevention in the home. Without proper clearance, charring begins to develop. It may take years before enough charring develops to ignite but the results are disastrous. Always follow the manufacturer's recommended clearance distances. Also consult your local building department. Remember your chimney requires clearance too!



Installations must meet or exceed the manufacturer's instructions and all applicable building and fire codes.

NOTE: Brick or stones provide little or no protection because they are good conductors of heat. To be effective, a dead air space of one inch should be between the bricks/stones and the combustible wall. Gypsum wallboard over studs is considered a combustible wall and heat can be transmitted directly to the wood studs beneath. Use only approved noncombustible materials to protect walls and floors. The material used to protect the floor should extend at least 18" beyond the stove on all sides. If in doubt on the non-combustibility of a product, contact your local fire department.

THE CHIMNEY OR FLUE:

The chimney should extend at least 3 feet above a flat roof. On pitched roofs the chimney top should be at least 2 feet higher than any point on the roof within 10 feet of the chimney. Ensure that the stove pipe and chimney is adequate for the wood stove desired. The chimney must be flue-lined. All metal pipes must be fastened together with rust-proof screws. Follow all manufacturer's safety specifications. A spark arrestor of ½-inch spaced 12-gauge wire screen is required over the chimney cap when a house is located in the wildland. Also remove any tree limb within 10 feet of the chimney (Public Resources Code 4291 c & f).

AIR INTAKE FOR BEST BURNING:

The best situation for supplying combustion air to a wood stove is to use outside air. The benefits in this system are both safety and efficiency. For mobile homes this is a requirement by law. Also, using only inside air, especially in newer air-tight homes may create health problems. This may result in much lower inside relative humidities and a reduction in oxygen. Using combustion air from within the house causes air flow throughout the house from all leaks around doors and windows. This creates a cool draft near the floor. Using outside air reduces these problems. Contact your local building department for suggestions on how to properly vent your wood stove to the outside.

WOOD HEAT AS A COMPARISON

Wood heat often is not the cheapest heat source and it requires more work. It is less convenient than heating with fuels fed automatically. However, if the cost of wood is low enough, you will save money. For those who enjoy work, the cutting, splitting and stacking of wood can be a pleasant form of exercise.

To compare heating costs you must convert costs of different fuels to cost per unit of heat. Cords of wood, gallons of oil, kilowatt hours of electricity, therms of natural gas and cubic feet of LP gas must be converted to a common heat content unit for comparison. The kilowatt hour and the therm are precise quantities of energy. But the volume of wood in a cord can vary considerably and the potential heat in a cubic foot of wood varies for different species. In addition, the heating value of wood, the stoves used, and the frequently required stove adjustments make wood heating calculations less than precise when compared to other sources of fuel.

TABLE 1. HEATING VALUES OF LOCAL WOOD

SPECIES OF WOOD	BTU/Cord (million)
Mountain Mahogany	35
Black Oak	26
Douglas-fir	25
Juniper	24
Lodgepole Pine	21
Ponderosa Pine	20
White Fir	19
Incense-cedar	18

CAUTION: Mountain Mahogany and pitchy pine limbs will burn very HOT!! Do not regularly use these woods in wood stoves as excessive high heat will damage the fire box and the chimney.

TABLE 2. COMPARISON OF OTHER FUELS TO A CORD OF WOOD

To compare with other heating fuels use the factors below to obtain equivalent cords of wood:

Oil	divide no. of gallons by 175
Coal	divide no. of pounds (not tons) by 1600
Gas	divide no. of thousand cubic feet (MCF) by 28
Propane Gas	divide no. of gallons by 220
Electricity	divide no. of kilowatts by 6500

NOTE: A cord of wood equals a tightly stacked 4 foot by 4 foot by 8 Wt rectangle of wood or 128 cubic feet.

TABLE 3. HEAT CONTENT OF COMMON FUELS

FUEL	UNITS PER MILLION BTU EFFICIENT HEAT
Natural gas	15.4 therms
Fuel oil	11.1 gallons
Coal	.067 ton
LP gas	16.5 gallons
Electricity	293.1 kwh (kilowatt hour)

TABLE 4. COMBUSTION EFFICIENCY OF TYPICAL HEATING UNITS

TYPE	EFFICIENCY
Standard fireplace	up to 10%
Fireplace inserts/tube grates	up to 20%
Simple updraft stove (Franklin)	up to 30%
Airtight stoves	up to 60%
Pellet fuel stoves	up to 90%

Using the above tables a person can determine whether wood heat is the most efficient way to heat the home. Or another question could be "How much can I pay for wood before it exceeds the price of my alternative heat source?"

The following example shows the step by step method of determining the most efficient way to heat the home. Obtain your own local fuel costs for the example. Remember, wood burns at a lesser efficiency than other fuels and the efficiency of the stove is also important. To do a proper comparison we must change to the BTU measurement (British Thermal Unit). See table #3.

EXAMPLE: "If I used 600 gallons of #2 fuel oil last year at a average price of $0.70 per gallon, would I be better off burning seasoned juniper purchased at $65.00 per cord?"

A simple calculation would show that you spent $420.00 for heat last year (600 gallons x $0.70/ gallon = $420.00).

From table #2 we calculate the fuel oil equivalent to a cord of wood equals 3.4 cords for the winter (600 gallons divided by 175 = 3.4 cords).

Therefore, if we had to purchase wood for heat it would cost us $221.00, or a whole lot cheaper. (3.4 cords x $65.00/cord = $221.00) Actually, we must go a step further and compare the efficiency of the wood and the stove. To do this we must change to a BTU measurement (British Thermal Unit).

From table #3 we see that fuel oil has a value of $7.77 per million BTU of efficient heat ($0.70 x 11. 1 = 7.77).

From table #I we see that juniper has a value of 24 per million BTU of efficient heat per cord.

From table #4 we see that our wood stove has an efficiency rating of 60%.
At a value of $65 per cord our wood could be compared by using the following equation:

$65/cord divided by 24/mBTU divided by 0.60 = $4.51 per mBTU

Thus to heat our home with wood would be cheaper. But because the wood stove is only 60% effective, we would have to purchase more wood than the original calculation would suggest:

3.4 cords divided by 0.60 efficiency = 5.7 cords

Thus 5.7 cords at $65-00 per cord = $370.50 for our winter heating bill.

Note: Your needs could be lower, depending on the size of the house and how well insulated it is.

Now, to determine how much we can pay for wood before its price exceeds the price of fuel oil:

Divide $420.00 paid for fuel oil by 5.7 cords of wood needed and we can pay up to $73.68 per cord before heating with fuel oil would be cheaper.

You can do the same calculations for other sources of heat or compare the BTU's of other firewood available. Remember, these figures are not that precise for wood due to its nature. Other factors such as moisture content and stove operation can greatly reduce the efficiency of burning wood. Wet wood alone can reduce the efficiency of a wood stove by an additional 50%. Much of the heat produced must be used to boil out the "free" moisture and the heat output of the stove will not increase much above 212 degrees, the boiling point of water, until the "free" moisture is gone.

WOOD STORAGE AND PROPER DRYING

As we have seen, burning wet, or unseasoned wood, will dramatically reduce the efficiency of your wood stove. It is a major contributor to creosote build-up and can be considered the number one cause of flue fires.

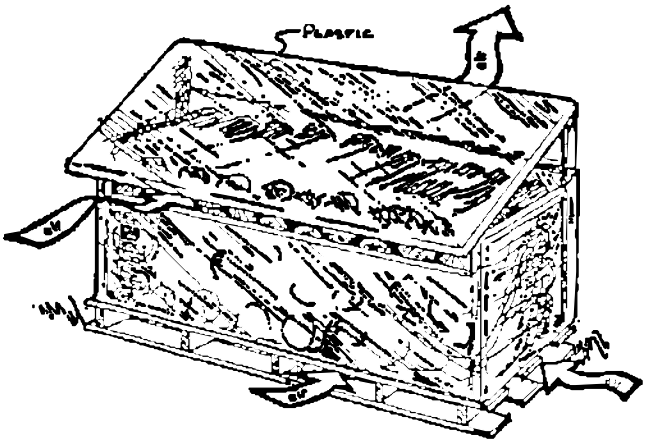
For these two reasons alone, everyone should be burning only "seasoned" wood. Either you should purchase seasoned wood or know how to air dry the wood yourself. Seasoned wood can be best described as wood that has been split and the wood color has a dull look, often looking slightly gray. Both ends of the piece should have numerous surface checks (shallow cracks) with usually one natural split. On soft-wood species such as pine, fir and cedar, the bark easily falls off when disturbed. For most species this process takes 8 to 12 weeks during dry weather or 18 weeks if the weather is damp.

HOW TO DRY FIREWOOD

Stack the wood off the ground and expose it to the sun and wind. Normally the stack should be only as wide as the length of two pieces of wood. The wood should be stacked no higher than the user can easily reach, as the stack can become unstable.

The top should be protected from the rain with a temporary roof of heavy plastic. Build a frame for the roof that is slanted to one edge. In this way, any condensation underneath will flow to the edge and drip off. Leave at least 6 inches of space between the rows for adequate ventilation and even drying. Stacking off the ground allows air circulation underneath and around the stack. If you see mold forming on the wood surface, you probably do not have adequate ventilation and the wood will take longer to dry.

AN EXAMPLE OF FIREWOOD PROPERLY STACKED FOR DRYING:



STORING WOOD SAFELY

Stored wood is subject to infestation from insects and rodents over time. Some insects that attack firewood can also attack exposed building timbers and even home furniture. Wood should be stored off the ground and away from the house. It should be kept dry but exposed to the sun and wind. Remember that a cord of wood (4 ft. x 4 ft. x 8 ft.) is the size of a sub-compact car. Be sure you have enough space before you buy your wood.

To prevent insect damage in the home, carry inside only enough firewood needed for daily use. Rotate the woodpile, always burning the wood you have had the longest. This helps avoid the build-up of insects and rot and assures that you burn the driest wood. Remember that dry wood is the most efficient and cost-effective way of heating your home with a wood stove.

If you live out in the wildland, where dry grass is a fire problem, don't stack your wood adjacent to a structure. It has been shown in the major wildfires of 1987 and 1988 that fire would sweep through a residential area, sparing the house but igniting the dry grass under the woodpile. As much as 3 hours after the fire front burned through, the ignited woodpile would develop enough heat to destroy the house.

SOURCES OF WOOD SUPPLY

Now that you have decided to heat with wood, you will need to consider how you will get an adequate supply for the winter. Many people enjoy gathering their own wood but timing is critical. Available wood cutting areas may have road and chain saw restrictions or actual closures may occur during the season. Usually you can cut unrestricted only in late spring or late fall.

You must know how much you will need for the entire winter. If you underestimate your needs you may run out during a critical cold spell when no other source is available. Remember, you need to get some wood in spring so that it will be seasoned by next fall.

No matter where you get your wood you must have a valid permit or prove that you are the legal owner of the wood. If you are cutting off your own property and transporting the wood into town, you will need proof that you own the property, such as an assessor's plat map with your name and mailing address on it.

EXAMPLES OF SOURCES OF WOOD

Public: Any USDA Forest Service office and most Bureau of Land Management offices (BLM) - see your telephone directory under "US Government." See page 15 for some local numbers.

Private: Some of the local timber companies and ranch timber owners sell wood permits. Some local sawmills sell mill ends or have damaged logs for sale. You must get permission of the landowner to cut firewood. Proof of that permission is necessary to transport firewood on state and county roads.

Remember to use a map, such as an ownership or "topo" map, to insure you are cutting wood on the correct ownership.

TO PURCHASE FIREWOOD

Firewood may be purchased through local private dealers. Your local newspaper usually carries several classified ads. It is best to buy your wood in spring to insure it is well seasoned by fall. Purchase your late winter or next year's wood in fall. Don't wait until the last minute. Wood purchased after December becomes very expensive. The average home takes about 5 cords of wood to heat each year. It is good advice to start out with 7 cords so that you always have dry, seasoned wood on hand.

Pellet wood fuel is now becoming locally available for the new and nearly smoke-free pellet stoves. Pellets are sold in 40 lb. bags lined with plastic to keep the pellets dry. These bags are available through feed stores and some hardware stores.

TYPES OF WOOD STOVES

The purpose of this section is to define some of the wood stoves available. It is not our intention to favor one type or brand over another. It is important to note that home-made stoves may pose a serious fire threat and may make your home fire insurance invalid.

CATALYTIC COMBUSTION HEATERS

Corning Glass Works has developed a catalytic afterburner for wood stoves that may increase the efficiency and decrease air emissions. It is intended to be built into stoves by the manufacturer and it is in the form of a ceramic honeycomb, coated with a metallic catalyst. The catalyst burner lowers the ignition point of smoke from 1300 ^{o}F to about 500 ^{o}F, allowing more of the smoke to burn before it leaves the stove. By burning the smoke, there is more complete combustion and less pollution. This catalyst is available only to stove manufacturers who design their stoves with a bypass around the catalyst in case it becomes plugged. Certain materials capable of clogging this catalyst include metallic paper and foil, manufactured logs with chemical binders and coal. The catalytic combustor has been introduced by a number of wood stove manufacturers and is now commercially available. Also catalytic inserts for wood stove flue pipes are available.

TWO-CHAMBER COMBUSTION SYSTEMS

Wood heaters which incorporate two separate combustion chambers within the same unit are available. The purpose of this two-chamber arrangement is to provide optimal conditions for the complete combustion of gases and charcoal formed during pyrolysis. Each chamber is fire-bricked lined and has separate air inlets for primary and secondary combustion air. Wood combustion occurs in the bottom chamber, with primary combustion air being introduced underneath the grate and toward the back of the unit. This causes the wood to burn from back to front. The volatile gases produced during the pyrolysis process flow to the upper chamber where a high-speed stream of preheated air along with high temperatures (2000 ^{o}F) cause combustion of the gases.

PELLET STOVES

A recent development for the home market is the pellet stove. This type of stove has been in use for 60 years by industrial users and now the design has been made small enough for home use. The basic principle is that stored, dry wood pellets are fed a few at a time into a burning chamber where, with forced air, they are burned at high temperatures. This gives the most efficient combustion for the wood used and results in very little smoke discharge. The stove does require electricity to operate and the pellets are more expensive than cordwood. The stove is considered the most fire safe.

ADDITIONAL READING MATERIAL

CALIFORNIA WOODHEAT HANDBOOK
1982 California Energy Commission and the California Department of Forestry, publication P500-82-047

WOOD HANDBOOK
1974 USDA Forest Products Laboratory

HEATING YOUR HOME WITH WOOD
1983 Cooperative Extension, University of California

HOME HEATING FACT SHEET
1982 National Fire Protection Association

A copy of one or more of these publications may be available from your local library, local county farm advisor, local Soil Conservation Service office, or your CDF area forester (see page 16).

LOCAL PUBLIC AGENCY TELEPHONE DIRECTORY

	Business Phone	Wood Recording
Modoc National Forest		
SO - Alturas	233-5811	
Adin	299-3210	299-3501
Canby	233-4611	233-5515
Tulelake	667-2246	667-2248
Cedarville	279-6116	279-2460
Lassen National Forest		
SO - Susanville	257-2151	
Chester	258-2411	
Eagle Lake	257-2161	
Fall River Mills	336-5521	
Plumas National Forest		
SO - Quincy	283-2050	
Quincy	283-0555	
Beckworth	836-2575	
Greenville	284-7126	
La Porte	675-2462	
Oroville	534-6500	
Milford	253-2223	
Bureau of Land Management		
Susanville	257-5381	
Alturas	233-4666	233-4668
Cedarville	279-6101	
Eagle Lake	257-0456	
Soil Conservation Service		
Alturas	233-4137	
Cedarville	279-6110	
Fall River Mills	336-5782	
Loyalton	993-4489	
Reno	(702) 784-5408	
Susanville	257-7271	

FOR SERVICE FORESTRY INFORMATION CONTACT YOUR AREA FORESTER

California Department of Forestry and Fire Protection
Lassen-Modoc Ranger Unit

Lassen County

Frank Goddard, Unit Forester
Susanville 257-4171

North Lassen and Modoc County

Barney Ward, Area Forester
Alturas 233-5811

Plumas and Sierra Counties

Ray Stine, Area Forester
Quincy 283-1792

Nevada Division of Forestry

Washoe County

Carson City (702) 885-4350

IN CASE OF A FIRE:

1. Be prepared - know what to do in advance. Keep a 5 lb., ABC type chemical fire extinguisher nearby.

2. In the event of an actual fire, close the damper and call the fire department. Know the emergency telephone number. In most areas it is 911.
As with any emergency, stay on the phone to give directions to your home, the nearest cross street, or any change in the fire situation.

3. With small flue fires**,** you can discharge an ABC chemical fire extinguisher into the fire box. Do so only if you can do it safely:

FIRST - Open the damper slightly for 30 seconds - this is necessary to expel unburned gases.

SECOND - Open the stove door SLIGHTLY to allow the stove to "breathe" - opening too rapidly could cause a back-flash explosion. Stand away from the opening and use gloves.

THIRD - Open door enough to discharge extinguisher - discharge all of the contents - Close the door and close the damper.

FOURTH - Check all spaces, the attic and the roof for any extension of the fire**.** Re-check the same areas 30 minutes after the fire is "out." Even if you think you were successful, it is still a good idea to call the fire department for a professional check-out of all spaces.