Backpacking Stoves I—How Safe is Your Stove?

Don't Get Burned—We Mean, Literally, *Burned.*

While testing stoves for our equipment evaluation, we became aware for the first time of just how dangerous stoves can be. It surprised us. Since our evaluating team has a combined total of 103 years' backpacking and stove-using experience, and since we weren't aware of the dangers, we wondered how many other backpackers might also be surprised.

Then, as we neared completion of our testing, we heard of the new research by two Worcester Polytechnic Institute of Massachusetts scientists which provides startling evidence that backpacking stoves give off far more deadly doses of poison gas than anyone ever realized.

Stoves *are* dangerous. And knowledge of the types of danger is essential for knowing how to use stoves safely. This becomes more important as more new people use stoves each year, many of them youngsters being introduced to the "New Ethic" of campfireless camping.

We decided to present our material on stoves in two parts to emphasize the importance of stove safety. The first part deals with the little-known aspects of stove accidents–and, more important, the potential for more serious accidents. The second part will present an evaluation of stoves themselves—their performance on the trail, efficiency, fuels, costs and specifications.

There is a wide variety of stove accidents, and it is difficult to gain much information on the more serious mishaps. In a quick accident survey, BACKPACKER learned about a number of incidents that did not always end in great harm but which, because of their nature, had a potential for serious personal injury.

Several common assumptions about stoves are not true. For instance, some boy scout troops are teaching the use of cartridge-type stoves instead of refillable-fuel stoves on the premise that cartridge-type stoves are safer. Not true. BACKPACKER found the same number of accidents with both types. But accidents with refillable-fuel stoves can be more easily avoided by more cautious use, while accidents with cartridge stoves are more likely to be caused by malfunctioning parts and thus are more unpredictable.

Since stoves can be as dangerous as guns, BACKPACKER believes there ought to be the same amount of drilling in the use of a stove as there is in the care and use of a rifle. With this attitude, and by using refillable stoves, most accidents can be avoided.

Our point can be discerned in a review of some of the following accidents:

Refueling. Hikers Mike and Brian were cooking dinner near the Vermillion Cliffs in Utah. Mike filled their stove with gas and set the fuel bottle aside, far enough away for safety. Then he began cooking dinner. Brian stood up to get something from his pack and knocked over the fuel bottle. Although the fuel bottle was two feet away from the stove, Mike had forgotten to replace its cap. The fuel flowed under the stove and caught fire, burning Mike's foam pad and sleeping bag.

In another example, Becky removed the cap from her stove's fuel tank to check the fuel level while the stove was burning. Pressure inside the tank caused the gas to run out. The flare-up badly burned Becky's face, and she nearly lost her sight.

Testing new stoves. Ray had never used a gasoline stove before. He bought one and decided to try it out in his fireplace at home before taking it on the trail. In filling the stove, he spilled fuel on the fireplace hearth. A hot coal in the fireplace ashes ignited the gasoline. He dropped the fuel bottle, and it rolled across the floor. Flames leaped up so fast there was no time to put them out. The house burned to the ground.

Knocked-over stoves. Neil was boiling water on his stove. All was well until he bent down to adjust the flame. It flared up and Neil jumped back, upsetting the stove. The pot of scalding water spilled on his foot and caused severe burns.

Puncturing canisters. Jay was changing the canister on his Bleuet Gaz stove while a second stove was burning nearby. In taking off the empty canister, he failed to unscrew completely the perforating pin that attaches the stove to the canister. When he put a new canister on the stove, the canister punctured prematurely and a jet of vapor spewed out. The vapor was ignited by the second stove. It cost Jay a tent and his sleeping bag.

Filling hot stoves. Pete and Sue were cooking inside their tent. The stove ran out of fuel. While filling it, Pete accidentally spilled gas on the hot burner. It ignited. The couple lost their tent and both sleeping bags, and luckily managed to get out of the tent without getting burned.

Overheating fuel tanks. To prevent explosions, and injury from flying metal, Coleman cartridges have a small melt-out plug on the cartridge rim which releases when temperatures reach 174 degrees Fahrenheit. In June, 1972, a scoutmaster was seriously burned when the melt-out plug released on his Coleman cartridge. He had surrounded his Gerry Mini Mark I stove with rocks to steady an oversized pot on the stove. The stove's heat was reflected down from the pot's bottom and was trapped around the stove by the rocks. The cartridge overheated, and the "safety" plug let loose, enveloping the area in a 10-foot fireball.

Fuel caps on self-pressurizing gas stoves also have a pressure-release valve. The danger here is that the opening on many models points at the cook. A California girl was seriously burned when the pressure valve on her stove released and spewed out an 18-inch flame. She had spilled fuel on the stove while filling the tank. When she lit the stove, the spilled fuel caught fire. She turned off the stove and sat down in front of it to wait for the flame to die down. But before it did, the tank overheated and the valve released a jet of vapor which ignited and flared in her face.

Defective cartridges. A family cooking breakfast at a campground in the Grand Canyon left their stove burning unattended on top of a picnic table. Although there was no source of heat near the stove, the cartridge erupted in a ball of flame.

David was replacing the cartridge on his Rich-Moor 7400 stove when the pressure seal on a 16.4-ounce Primus propane bottle burst. An icy jet of vapor spewed out without igniting. David passed the incident off as a freak accident—until a week later when a second cartridge blew a seal and sprayed his shirt with fuel. Again, no harm was done since it did not ignite. But what if David had been a smoker?

Throwing empty cartridges into a fire. Jane thought her Gerry cartridge was empty. She tossed it into a fire pit that had been used recently. An hour later the cartridge exploded. Fortunately, no one was near the pit at the time.

Flare-up. Lighting a butane stove at a low temperature can cause an unexpected flare-up. That happened to two cross-country skiers in California in 1974 when they lit a butane stove inside their tent. It flared, ignited the mosquito netting and melted a gaping hole in the tent wall. A flare-up can be caused by shaking a butane canister, too. With the skiers that may have been a more important factor than temperature.

Panic. Accidents can happen even when hikers *believe* they are being cautious. In July, 1973, a hiker in Kandersteg, Switzerland, took his stove outside his tent to prime it. Windy gusts kept blowing out the prime. On the third attempt he gave it an extra good prime and left the burner valve open. When he lit it, the stove flared up three feet. He panicked and kicked his stove away—right into his tent. He burned up his tent, sleeping bag and parka. What if someone else had been inside the tent?

Fire, however, is only one of the hazards of using a stove inside a tent. Even more dangerous are the risks of asphyxiation and carbon monoxide poisoning. We have read that more winter camping deaths occur from these causes than any other.

Carbon monoxide poisoning. If ventilation is inadequate, a burning stove can quickly use up all the oxygen in a tent, causing asphyxiation. The problem is greater in nonporous tents such as plastic tube models. You will usually be warned of the danger—possibly awakened from sleep—by gasping for breath.

Additionally, using a stove in a confined space can be as lethal as being in a closed garage with a car's motor running, because stoves, too, give off deadly carbon monoxide gas.

A hiker is most likely to expose himself to the danger of carbon monoxide poisoning in bad weather, when he closes his tent against the elements.

Any stove can cause carbon monoxide poisoning in a tightly closed tent, as Drs. Robert Wagner and Joseph Kohler of the Worcester Polytechnic Institute of Massachusetts found in some recent studies. Details of those studies are reported more fully on pages 67-69.

Below is a list of safety precautions for the use of stoves. Most important, use common sense.

How to Use Your Stove Safely

• Try your stove at home. Before you take a new stove on the trail, give it a few test runs. Carefully follow manufacturer's directions. If you have questions about how to operate it, call a backpacking shop or even the manufacturer.

• Be sure of adequate ventilation. Best to cook outside your tent. If you must cook inside, be sure to open the tent flap slightly even though the tent has a vent. It should, of course, have a vent; be sure *that* is open, as well. With a flow of fresh air, you eliminate most dangers of carbon monoxide poisoning and asphyxiation. If your tent cannot be adequately ventilated, do not cook inside.

That is true also for the use of camp lanterns, hand warmers, everything that burns fuel inside a tent.

• Place your stove in a safe place. Make sure it sits on a level surface where it is least likely to get knocked over. Set it up far enough from burnable materials—dry leaves and grass outside the tent, and tent walls, mosquito netting and sleeping bags inside it—so that if it flares up or malfunctions it won't start a fire.

• Don't overfill. Three-quarters full is better than too full. When a tank is too full, it can build up too much pressure while the stove is burning.

• Don't overprime, especially if you use your stove inside your tent. Excessive priming will cause a large flare-up. One way to avoid too much fuel in priming is to use an eye-dropper. The plastic kind won't break as easily as glass. If you should overprime your stove, sop up excess gas with a rag or tissue and lay it out on the ground a good distance away for the fuel to evaporate.

Some packers carry a squirt bottle of alcohol to use for priming. It causes less flare-up than gas.

• Replace the fuel cap before priming.

• Keep the fuel-regulating valve closed while you prime the stove.

• Don't spill fuel. If you spill fuel on a stove while you are filling it, clean off the stove with a rag or tissue. Let the stove sit until any excess fuel has evaporated before you light it. If fuel spills on the ground, move the stove to a new position. In a tent, spilled fuel should be cleaned up immediately. Then allow the tent to air adequately before you light your stove.

• Use correct fuel. Use the cartridges recommended for your stove; don't interchange them. Their thread fittings vary. If the recommended cartridges are not available, use another stove.

• Don't use oversize pots. Tall stoves are tippy. Using a large pot will make the stove top-heavy, and it can be easily upset.

On some stoves, too large a pot will reflect heat back on the fuel tank and cause it to overheat.

• Avoid overheating the fuel tank. Feel the fuel tank occasionally. *On gas stoves* tanks must be warm to generate pressure. On *propane and butane stoves* cartridges should be cool to the touch. But if either a fuel tank or a cartridge feels hot, turn off the stove. Be sure it has cooled before you relight the stove.

On stoves where a flexible tube connects the burner to the fuel canister (Prolite Pocket Stove and some Rich-Moor models), keep both the tubes and the fuel cartridges away from the burner.

Always make sure your stove is sufficiently ventilated to avoid heat buildup. Don't surround it, for instance, with a wall of rocks that would prevent fresh air from circulating around the bottom.

In wind, ensure that the stove's flame is blowing away from the fuel tank. Despite heat shields on some stoves, a flame blown in the direction of the tank can overheat it.

• Turn off the stove if it is not working properly. Remove the pot, also. Check the stove thoroughly to make sure all connections are secure and the fuel tank is not overheating. Then relight it. If the trouble persists, stop the stove and eat cold cuts.

• Refuel away from open flame.

• Turn off the stove before you check the fuel level or a cartridge connection.

• Do not refuel a hot stove. Sometimes a stove will run out of fuel in the middle of your cooking. Patience! Allow the stove's burner to cool before you refuel. Not only is there a risk of the stove catching fire, but the fuel bottle also can go up in flames.

• Replace gas canisters with care. If the cartridge is difficult to screw in, don't force it. You could damage the valve. Before you start the stove, be sure the connection is secure.

If you hear a faint hiss when you attach a new cartridge to a propane or butane stove, it may be leaking gas. Check the connection immediately. Try to solve the problem by attaching the cartridge properly. If gas continues to leak, replace the cartridge.

One way to check for a leak is to touch the canister. Even a pin-puncture on a butane cartridge will cause it to feel frosty.

Also, avoid shaking gas canisters. Doing so will cause them to shoot up a large flame at start-up.

• Be sure caps on spare fuel bottles are replaced firmly after refueling. Always place the bottles several feet from your stove before you start it.

• Dispose of empty cartridges properly. Before you throw a cartridge in the trash, make *sure* it is empty. If it still has fuel in it, light the stove and burn out the rest of the fuel. And, of course, pack the cartridge out with you.

• Clean your stove according to the manufacturer's directions and as often as recommended. As fuel burns in a stove, it leaves a residue on the stove's innards. With use, this builds up. Trail grime and cooking spills also can clog parts. The buildup can cause your stove to burn unevenly.

• Treat your stove with care. Stoves are delicate. If you should drop yours, check it out before you use it. Bent connections or fuel regulating valves can leak.

• Keep cool. If something goes wrong, think before you act. A moderate flare-up can get out of hand if you panic and push your stove away.

New Research Proves Backpacking Stoves More Deadly Than Suspected

Lethal levels of carbon monoxide given off by backpacking stoves in normal use.

While backpacking in New Hampshire's White Mountains last winter, four members of our party of 12 complained of dizziness, headaches and nausea after supper. The symptoms were the same as those associated with altitude sickness, but we were camped at only 3400 feet. All four men felt fine the next morning, and the incident passed without explanation.

Several months later we found a small winter-stove and cook-kit combination at a low price at a local hardware store. We bought a stove and decided to try it out by cooking lunch in an office at work. After 30 minutes, we noticed we felt dizzy and were experiencing mild headaches. We smelled combustion odors and decided to test for carbon monoxide. Our suspicions were confirmed when we found carbon monoxide levels of more than 100 parts per million (ppm) near the stove.

We recalled the complaints of the four men during our winter trip. Unlike the rest of the group, they had cooked supper inside their tent because of severe winds and a low temperature. We decided their discomfort probably had resulted from exposure to a high level of carbon monoxide produced by their mountain stove.

Why Carbon Monoxide Is Dangerous. Carbon monoxide (CO) is a colorless, almost odorless gas that results from incomplete combustion of hydrocarbons. In the body some of the blood's hemoglobin that ordinarily would pick up oxygen in the lungs picks up CO instead, so the amount of oxygen in the blood is reduced. The CO reacts with the hemoglobin to form carboxyhemoglobin. The amount of carboxyhemoglobin formed depends on the concentration of CO and the duration of exposure. Low amounts cause headache, dizziness and nausea; high amounts cause coma and death. An increase in altitude increases the severity of the effects because of the low oxygen saturation in one's blood.

We decided to investigate the concentrations of CO produced in a standard mountaineering tent by backpackers' and mountaineers' stoves. We used an uncoated nylon tent of A-frame construction, the Crestline from Recreational Equipment, Inc.

We tested eight stoves: Bleuet (butane), Gerry Mini (liquid propane gas), Gerry Mini Mark II (lp gas), Primus Grasshopper (propane), Optimus 77A (methanol), Svea 123 (Coleman fuel), Optimus 111B (Coleman fuel) and MSR (Coleman fuel). The Svea 123 was tested with the Sigg Tourist Cook Kit, the Gerry Mini stoves in the Gerry Tourist Cookset and alone, and the Optimus 77A in the cookset sold with the stove. All stoves were clean and in excellent operating condition.

How the Stoves Were Tested. An identical procedure was followed in all experiments. Stoves were centered 18 inches from the front entrance of the tent. Sampling probes were held by a ringstand placed 28 inches from the center of the front entrance at a height of 24 inches, representative of the head level of a person cooking.

Tygon tubing connected the probes to two CO analyzers (Ecolyzer, Energetics Science) capable of measuring CO concentrations from 0 to 100 ppm. Measurement of levels greater than 100 ppm was made possible by using a metering pump (Masterflex, Cole Parmer) to bleed in an equal volume of dilution air. Both analyzers were calibrated and checked against each other at levels below 100 ppm.

Preliminary tests were conducted outdoors on a calm, 60° F. day; extensive testing was done in a well-ventilated laboratory at 60° F.

The tent was pitched normally, without its fly. The nine-inch circular vent in the rear was kept fully open, and the front flap was zipped partly closed to form a triangular opening measuring 10 x 10 x 12 inches at the tent's apex. Clamps were placed on the zipper to ensure closing to the same position in each experiment.

Prior to each experiment, the analyzers were zeroed and calibrated, and background levels of CO were recorded. They measured a maximum of 5 ppm at the beginning of each test and never exceeded 8 ppm.

Three pints of water at 60° F. were placed in a 2½-quart aluminum pan (Sigg). Each stove was started outside the tent. As soon as it reached stable operating conditions it was placed inside the tent in the position indicated. The pot was centered on the burner, the door was quickly zipped shut as far as the clamp stops, and a stop-watch was started. Concentrations of CO were recorded at one-half or one minute intervals until the levels stabilized. The stoves were run for 15 minutes.

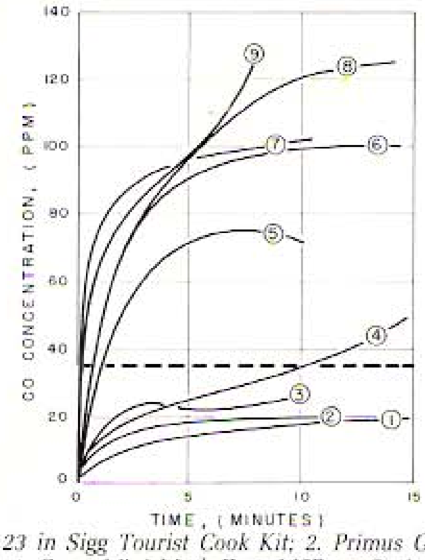
What the Tests Showed. The CO concentrations produced by the Optimus 77A, the Gerry Mini (with and without the Gerry Tourist Cookset), the Optimus 111B

Authors Joseph Kohler (left) and Robert Wagner set up an analyzer inside a tent to measure carbon monoxide dangers of backpacking stoves. The tent was made of breathable nylon, pitched without rain fly to simulate actual mountaineering use. During the tests, the tent's rear vent was open and the tent entrance was zipped partially open. After five minutes most stoves had filled the tent with dangerous quantities of carbon monoxide.

Tables of Deadly Doses

Here's How Much Carbon Monoxide the Stoves Gave Off

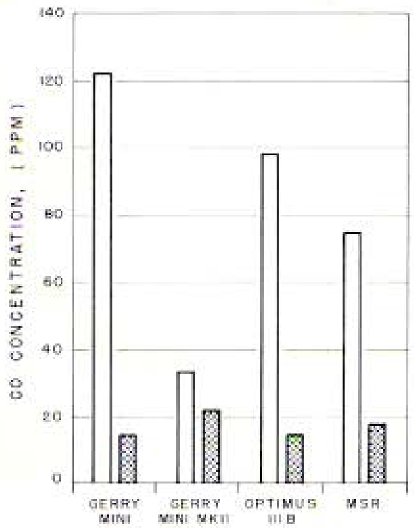
The curves on the chart indicate incremental levels of carbon monoxide in the tent produced by the burning stoves. The authors took carbon monoxide measurements at one-minute intervals. Curves were plotted from these measurements. The horizontal dotted line indicates the maximum level of carbon monoxide considered "safe" by the Amended Air Quality Act of 1970.



1. Svea 123 in Sigg Tourist Cook Kit; 2. Primus Grasshopper; 3. Bleuet; 4. Gerry Mini Mark II; 5. MSR; 6. Optimus 111B; 7. Optimus 77A; 8. Gerry Mini; 9. Gerry Mini in Gerry Tourist Cookset.

When Pot Supports Were Raised

The authors found that carbon monoxide dangers of stoves were reduced by raising stove pot supports one inch, high enough so the flame did not touch the pot bottom. While it took longer to boil a quart of water, the carbon monoxide emission was lowered to safer levels.



Concentration of CO at boiling point, with pot supports raised one inch

Concentration of CO at boiling point, with stove as supplied by manufacturer

Some Little-Known Effects of Carbon Monoxide Poisoning

Carbon monoxide (CO) combines with hemoglobin in the blood to form carboxyhemoglobin (HbCO). This reduces the ability of the blood to transport oxygen as oxyhemoglobin (HbO_2). At sea level 97% of the hemoglobin in the blood is bound with oxygen as HbO_2. Carbon monoxide reduces this amount by tying up hemoglobin. The resulting condition is termed hypoxia. Hypoxia can also be caused by low oxygen pressure at high altitudes or by certain diseases.

The amount of HbCO formed depends on the concentration of CO, the duration of exposure and the rate of breathing.

The physiological effects of hypoxia increase progressively as the level of HbCO increases and the level of HbO_2 decreases. The first symptoms appear at HbO_2 levels between 95% and 92% saturation, when an individual may begin to experience impairment in time interval discrimination, visual acuity and other psychomotor responses. The symptoms become more noticeable as the HbO_2 level drops to 90% saturation. The individual may experience drowsiness, lassitude and mental fatigue. At 85% saturation, headache, occasional nausea and euphoria may be experienced. The symptoms intensify and are dominated by a throbbing headache as the concentration of HbO_2 drops to 80% saturation. Vomit and collapse occur at 70% saturation, coma at 60% and death at 40%. The ambient air quality standards as legislated by the 1970 Amended Air Quality Act limit the maximum average concentration of CO for a one-hour exposure to 35 ppm, or an HbO_2 saturation level of 95.25%.

As an example, consider two winter mountaineers camped at a low elevation in an A-frame tent. Let's say they spend two hours melting snow, boiling water and cooking. This would expose them to approximately 100 ppm CO from the stove. This would result in HbCO levels of 5%. The HbO_2 level in their blood would be 92% (the normal 97% minus the 5% tied up as HbCO). The mountaineers might feel unpleasant and experience some impairment in visual acuity and other psychomotor responses but would be in no danger.

The effects of breathing CO increase dramatically at higher altitudes. As altitude increases, atmospheric pressure decreases and oxygen saturation in the blood decreases. The following table shows the oxygen saturation at various altitudes for a person breathing pure air.

Altitude (feet)	Percent of O_2 Saturation
0	97
5,000	95
10,000	90
15,000	83
20,000	70

Since both altitude and carbon monoxide reduce the oxygen saturation of the blood, their effects are approximately additive. Suppose our winter mountaineers cook in their tent at an elevation of 5,000 feet, instead. The HbO_2 saturation in their blood would be 95% (the normal amount at 5,000 feet) minus the 5% reduction caused by the stove, or 90%. They would experience drowsiness, lassitude and mental fatigue.

At 10,000 feet the mountaineers' HbO_2 levels would be 85% saturation. Headache, nausea and euphoria could ensue, and they could be in some danger.

At altitudes higher than 10,000 feet, exposure to levels of CO becomes very dangerous. At altitudes of 17,000 feet, the mountaineers could vomit and collapse.

These effects represent what typical mountaineers might experience under the conditions indicated. But they might vary considerably from one individual to another depending on physical condition, acclimatization to altitude and amount of exercise.

and the MSR rose rapidly during the first few minutes, then stabilized when the rate of CO escaping from the tent became equal to the rate of CO produced by the stoves. The final concentrations produced by these stoves ranged from 70 to 130 ppm. (The Gerry Mini in the Tourist Cookset might have produced higher levels, but the stove ran out of fuel.) The CO concentrations produced by the Bleuet, the Primus Grasshopper and the Svea 123 with the Sigg Tourist Cook Kit rose at a slower rate and stabilized at much lower levels—20 to 25 ppm. The CO level produced by the Gerry Mini Mark II had not stabilized when the run was terminated.

What caused the high concentrations? Clearly, the greater the rate of production of CO, the higher the final concentration in the tent. The rate of CO production depended on two factors: the amount of fuel and oxygen combusted by the stove (the output of the stove) and the degree of incomplete combustion (the amount of CO produced by the amount of fuel burned). The output was determined easily by the output of energy: the Optimus 111B and MSR had high outputs; the Gerry Minis, the Optimus 77A and the Svea 123 had moderate outputs; and the Bleuet and Primus Grasshopper had lower outputs. We determined the degree of incomplete combustion by measuring the CO concentration very near each stove—by placing the probe from the ecolyzer close to the burner while the stove was operating without pans on its supports. We found that the Optimus 111B and 77A, MSR and Gerry Minis did not produce a CO concentration as high as that at head level inside the tent.

Then we repeated the tests for incomplete combustion, this time with pans of water placed on the stoves, and got quite different results. The concentrations of CO near the bottom of the pan were more than 200 ppm in every case except for the Svea 123 with the Sigg Cook Kit, which produced 30 ppm exactly as it had before when no pan was used. The reason for high production by the other stoves was apparent: the flame impinged on the pan. We decided the cold pan surface caused quenching (cooling) of the flame, which resulted in incomplete combustion and CO production. The flame of the Svea 123, however, did not impinge on the pan.

We raised the pans on several stoves. When flames no longer impinged on the pans, CO concentrations dropped.

Next we modified several stoves to prevent flame impingement and lower the amount of CO produced. The Optimus 111B was modified by replacing the pan supports with supports one inch longer. The pan support for the MSR stove was first raised three-fourths of an inch, then one inch. The short windscreen on the Gerry Tourist Cookset was replaced by the windscreen from the Sigg Cook Kit, which was 1¼ inches taller.

The original experiments were repeated using the modified stoves. The CO levels produced by both Gerry Minis with the modified cookset and the modified Optimus 111B were dramatically reduced and were well within safe limits. The CO concentration produced by the MSR with the pot raised three-quarters of an inch was reduced, but still high; with the pot raised one inch, the level was very low.

Conclusions. It is apparent from our tests that several of the high-output stoves used by winter mountaineers produce high levels of carbon monoxide in a partially vented, breathable nylon tent as a result of incomplete combustion caused by flame quenching. It is likely most other high-output stoves produce similar levels and that even low-output stoves could produce high levels in a coated nylon tent.

Exposure to such levels of carbon monoxide probably is not dangerous at low altitudes although it may lead to discomfort. At altitudes above 10,000 feet, however, carbon monoxide poses a potentially dangerous hazard by reducing the already low oxygen saturation of the blood. The effects would depend also on the performance of the particular stove, the ventilation of the tent and the duration of cooking time.

COMING: STOVES II

Evaluation of the Leading Stoves

In the next issue, BACKPACKER reports on backpacking stoves—each model's backpackability, cooking efficiency, and overall safety. For the first time, stoves are evaluated both for three-season use as well as for their performance in winter.

BACKPACKER editors spent several months running a series of tests on each stove. Cold weather performance was tested in Vermont in January. Boiling times were checked at sea level, again at a 5200-foot altitude and once more at a shelter in the Colorado Rockies at 9500 feet. Each stove was tested for how well it simmered and how long it ran on one filling of fuel. The stoves were taken on backpacking trips to provide a "feel" for how each operated in characteristic outdoor cooking situations.

In addition, we report on the different types of fuels and the advantages of each, on how altitude affects a stove's performance, on how to care for your stove. There are even some hints on how you can get better efficiency from your stove in the wind and on a cold morning.

Did you know, for instance:

1. That in wind the distance between the burner and the pot is just as important as a good windscreen.

2. That a stove's weight is not its real weight. One model we tested weighs only 11 ounces, but it takes 10 minutes to boil a quart of water, while another stove weighing nearly two pounds boils a quart of water in four minutes. The difference in the weight of fuel consumed makes the 11-ounce stove the heavier of the two!

3. That while prices of stoves range from $2 to $50, that is only a part of the total cost. Fuel for the $2 stove costs nearly 40 cents an hour, while the $50 stove burns on only seven cents an hour. A case of cheaper being more expensive!

And much more.

If you are a gourmet, you may opt for a model with a precision burner control valve which allows fine adjustments for simmering. On the other hand, if cooking is a chore for you, you may put up with a heavy stove because it boils water in a flash. Or, if you are a solitary backpacker, you may want an ultralight stove despite its inefficiency because you know you rarely will boil more than a quart of water.

Which stove is right for you? Don't miss BACKPACKER's report on stoves in our next issue. This is the most extensive evaluation of backpacking stoves ever attempted.