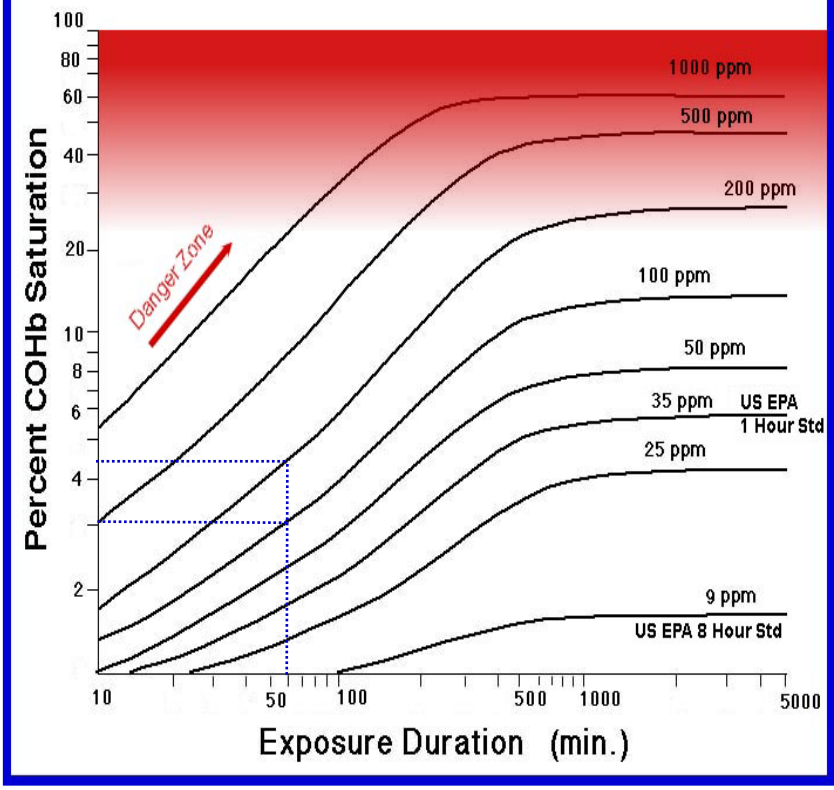
CO fact sheet-1

Complete combustion of fuels yields only CO_2 and water vapor, but when fuels are burned in non-ideal conditions, other compounds are emitted. These compounds are called products of incomplete combustion (PICs), and include carbon monoxide (CO), methane (CH_4) and other volatile organic compounds (VOCs) as well as particulate matter (PM). CO is the most prevalent PIC. The effect of high levels of exposure to it can be lethal, but even low levels of exposure can have harmful effects

- CO diffuses rapidly blood vessel membranes.
- Once it's present in the bloodstream, ***CO binds to hemoglobin 200 times more readily than oxygen***. This forms carboxy-hemoglobin (COHb).
- COHb reduces the oxygen carrying capacity of the blood and impairs the release of oxygen from hemoglobin…The neurobehavioral effects include impaired coordination, tracking, and driving ability. Cognitive performance is impaired at COHb levels as low as 5%.
- During exposure to a fixed concentration of CO, the COHb concentration increases rapidly at the onset of exposure (see graph below). This levels off after about three hours, and reaches steady state after 6 – 8 hours of exposure (see graph below).
- Headache, nausea and loss of consciousness occur at COHb levels of 25-40%. **Permanent brain damage and death follow if COHb levels exceed 45%.**



This graph shows the level that COHb will reach in the bloodstream of a typical adult as a function of time for a range of exposures. *Notice that both time and COHb scales are logarithmic.*

How to read the graph: After one hour at 100 ppm, a person's bloodstream will likely have a COHb level of ~3%, which has physical effects that are barely noticeable. After several hours at that exposure, it will level off at around 15% COHb. At this level, the exposed individual is likely to feel a mild headache. If the concentration of CO is doubled to 200 ppm, there will be little difference after one hour, but after several hours, the concentration of COHb will level off at ~30%, which is at the edge of the danger zone where drowsiness, nausea, and unconsciousness can occur.

Note: all individuals react to CO differently. This plot is only a rough guide to assessing the effects of CO exposure.

If you suspect that someone has become sick from breathing CO, immediately move the person to fresh air. If they show any signs of acute poisoning including nausea, headache, or drowsiness, call 911 immediately.

CO fact sheet-2

24-hour average indoor concentrations of CO due to wood and charcoal combustion in developing countries typically can be between 100 and 200 ppm with peak episodes as high as 400 ppm lasting several hours (see below).

People who are consistently exposed to high levels of CO, like heavy smokers or cooks in less developed countries, often adjust to compensate for lower levels of oxygen in the bloodstream, but they still risk developing chronic health effects. However, people who are not accustomed to CO exposure could easily become acutely ill from high concentrations of CO like those indicated in the plot below, which were measured in a Kenyan house burning wood in an open fire.

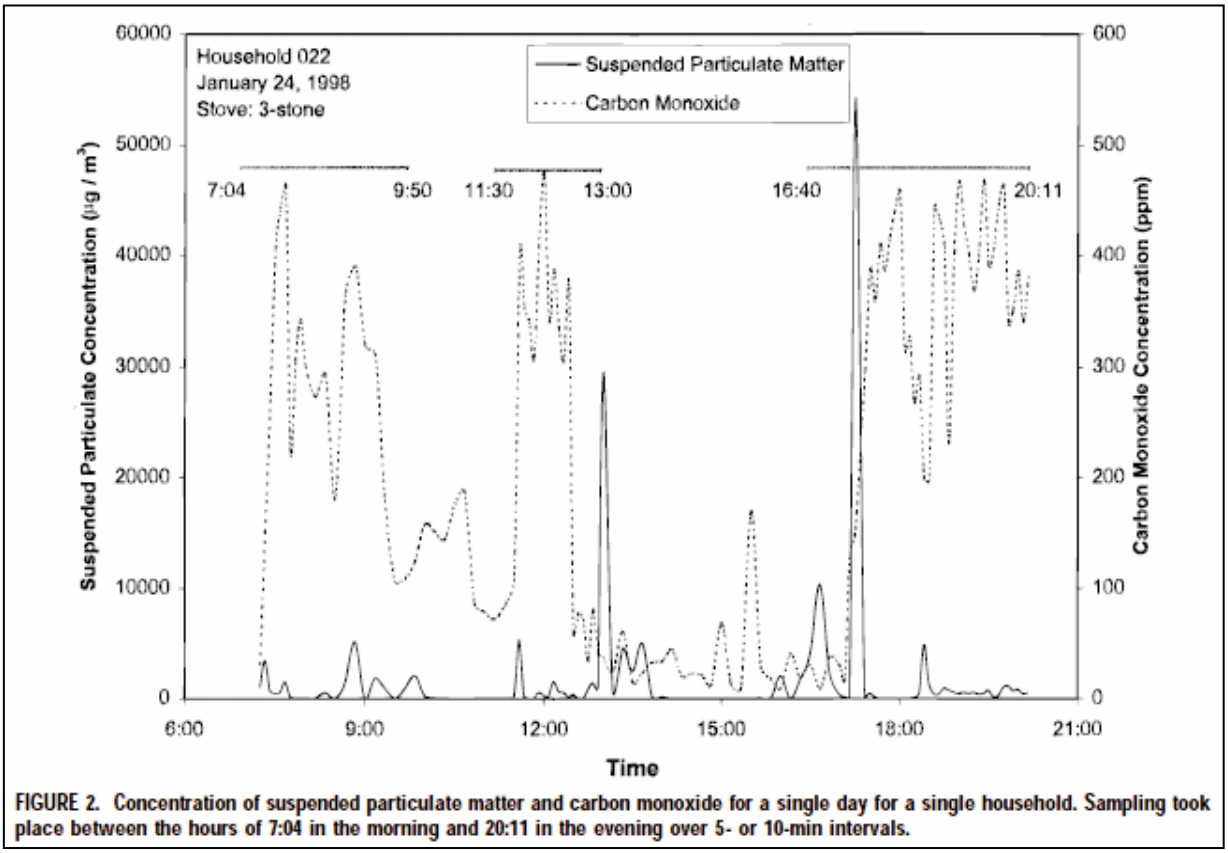


FIGURE 2. Concentration of suspended particulate matter and carbon monoxide for a single day for a single household. Sampling took place between the hours of 7:04 in the morning and 20:11 in the evening over 5- or 10-min intervals.

From Ezzatti et al., 2000, Comparison of Emissions and Residential Exposure from Traditional and Improved Cookstoves in Kenya, *Environmental Science and Technology*, **34** p. 578-583.

CO exposure standards from the WHO and USEPA					
	[CO]	Time of exposure *not to be exceeded*		[CO]	Time of exposure *not to be exceeded*
WHO	10 mg/m^3	8 hours	**EPA**	9 ppm	8 hours
	30 mg/m^3	1 hour		35 ppm	1 hour
	60 mg/m^3	30 minutes			
	100 mg/m^3	15 minutes			