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**MSHA's Occupational Illness and
Injury Prevention Program
Health Topic**

"Carbon Monoxide"

**Your
Health
Comes
First!**

Background

Carbon monoxide (CO; CAS 630-08-0) is a colorless, odorless, tasteless gas produced by the incomplete combustion of carbon-containing material such as coal, wood, paper, gasoline, and diesel fuel. Known to miners as white damp or the silent killer, CO constitutes a serious health hazard and exposure to it may even lead to death. When inhaled, CO easily enters the blood stream through the lungs. CO interferes with the blood's ability to deliver oxygen to the tissues because it attaches to hemoglobin (the oxygen carrier in the blood). Usually, hemoglobin carries oxygen to the tissues. Hemoglobin combines more readily with CO than with oxygen having an affinity for CO 200-300 times greater than for oxygen. Once combined with CO, hemoglobin cannot carry oxygen, causing a lack of oxygen in the blood stream despite sufficient oxygen in the ambient air. Therefore, because the blood cannot deliver sufficient oxygen to the tissues, they begin to die. The miner actually suffocates as the result of chemical asphyxiation.

Occurrence

Carbon monoxide can be found in underground and surface mines in poorly ventilated or confined spaces. At typical mining operations the most common sources of CO are internal combustion engine exhaust and explosives detonation. In coal mines, CO can also be produced by the low temperature oxidation of coal. Ambient levels of CO in mine atmospheres may vary depending on the characteristics of the coal. Elevated levels of CO are commonly found adjacent to gob areas and in bleeder entries and must be carefully monitored.

During recovery operations following underground mine fires or explosions, special attention must be given to the detection of CO. Although fires and explosions are rare events, they can produce significant volumes of CO. The likelihood is much greater for a miner to be killed by exposure to CO than by direct burns from a fire or explosion.

Health effects

The lack of warning signs makes CO especially dangerous. Miners with heart or lung problems are especially susceptible to CO poisoning. Frequently, miners are exposed to CO without realizing it. Early signs of acute CO poisoning include headache, blurry vision, drowsiness,

dizziness, weakness, and confusion. Initially the victim may have pale skin. Later the skin and mucous membranes turn cherry red due to the CO combining with blood hemoglobin. If the exposure continues, these symptoms may be followed by nausea, vomiting, ringing in the ears, and breathing difficulty. Finally, the victim loses consciousness and enters a coma. If the victim does not receive oxygen, the victim will die. If the victim does not die, he/she may incur permanent brain damage. In extremely high CO concentrations death can occur within only a few minutes.

An electronic CO meter with an alarm setting can be a valuable tool to check the atmosphere in areas where CO is likely to occur. The alarm warns the miners to exit the area before they are overcome by CO. Proper training in the use of handheld detection devices and procedures to follow when CO is detected is important to the safety of miners. All miners should be made aware of CO's toxic symptoms shown in Table 1. Miners should be trained in the hazards of CO. When CO may be present, miners should check to ensure that ventilation is sufficient to maintain the CO level well below the exposure limit.

Table 1. Concentration of CO in PPM and Percent and Associated Health Effects

PPM	Percent	Health Effects
0-1	0.0001	None; normal background levels
9	0.0009	None; recommended maximum allowable concentration in short term living area
50	0.005	Maximum exposure allowed in the workplace for 8 hours (MSHA)
200	0.02	Mild headache, fatigue, nausea and dizziness
400	0.04	Serious headache - other symptoms intensify. Life threatening after 3 hours maximum exposure allowed in the workplace for 15 minutes (MSHA M/NM)
800	0.08	Dizziness, nausea and convulsions - unconscious within 2 hours - death within 2 to 3 hours
1600	0.16	Headache, dizziness and nausea - death within 1-2 hours
3200	0.32	Headache, dizziness and nausea - death within 1 hour
6400	0.64	Headache, dizziness and nausea - death within 25 to 30 minutes
12,800	1.28	Death within 1 to 3 minutes

Treatment for CO poisoning includes removing the victim to fresh air and rest. If the victim has lost consciousness a medical emergency has occurred and immediate emergency medical attention is required. Medical technicians will administer oxygen and transport the victim to the hospital for additional treatment. Fortunately, most CO poisoning victims recover completely.