biosystems Application Note	**Carbon Monoxide and Hydrogen Sulfide: The leading toxic hazards in confined space entry**	Date	02/09/05
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Toxic contaminants in the workplace

There are many toxic substances which are commonly encountered in industry. The presence of the toxic contaminants may be due to materials being stored or used, the work being performed, or may be generated by natural processes.
Carbon Monoxide and Hydrogen Sulfide are the two most widely occurring toxic gases, especially in confined space entry. Carbon Monoxide is a by-product of incomplete combustion, and will always be present whenever combustion occurs. Hydrogen Sulfide is another very common and very dangerous toxic gas. It is generally produced by bacterial action on materials which contain sulfur. It is especially associated with raw sewage, crude oil, animal products, and the pulp and paper industry, but can be encountered occasionally in almost any confined space.
Airborne toxic substances are typically classified on the basis of their ability to produce physiological effects on exposed workers. Toxic substances tend to produce symptoms in two time frames. Higher levels of exposure tend to produce immediate (acute) effects, while lower levels of long-term (chronic) exposure may not produce physiological symptoms for years.

Hydrogen sulfide

Hydrogen sulfide (H_2S) is a good example of an acutely toxic substance which is immediately lethal at relatively low concentrations. Exposure to a concentration of only 300 PPM (parts per million) for a period of 30 minutes is enough to render a worker unconscious. Exposure to a 1,000 PPM concentration of H_2S in air produces rapid paralysis of the respiratory system, cardiac arrest, and death within minutes. Hydrogen sulfide is readily produced by the action of anaerobic sulfur fixing bacteria on materials which contain sulfur. At low concentrations hydrogen sulfide smells like rotten eggs. At high concentrations it desensitizes the sense of smell, and is no longer nose detectable. H_2S is colorless, heavier than air, corrosive, flammable (LEL is 4.3 %), soluble in water, and extremely toxic!

Carbon monoxide

Carbon monoxide is a colorless, odorless, tasteless gas produced as a by-product of incomplete combustion. It is strongly associated with internal combustion engine exhaust, leaky heating systems, and many other common processes which involve combustion.
Carbon monoxide (CO) is a good example of a chronically toxic gas. Carbon monoxide bonds to the hemoglobin molecules in red blood cells. Red blood cells contaminated with CO are unable to transport oxygen. Although very high concentrations of carbon monoxide may be acutely toxic, and lead to immediate respiratory arrest or death, it is the long term physiological effects due to chronic exposure at lower levels that take the greatest toll of affected workers. This is the situation with regards to smokers, parking garage attendants, or others chronically exposed to carbon monoxide in the workplace. Exposure levels are too low to produce immediate symptoms, but small repeated doses reduce the oxygen carrying capacity of the blood over time to dangerously low levels.
This partial impairment of the blood supply may lead over time to serious physiological consequences. The only way of being sure that carbon monoxide is not present in dangerous concentrations is to look for it with an atmospheric monitor designed to detect it. Since carbon monoxide is encountered so frequently in so many settings, there is sometimes a tendency not to take it seriously as a hazard. Don't make that mistake!
High concentrations of carbon monoxide can saturate a person's blood in a matter of minutes, and quickly lead to respiratory arrest or death. Constant monitoring is the *only* way to insure that the air is safe from this invisible hazard.
Toxic effects of carbon monoxide exposure:

Permissible exposure limits

Permissible exposure limits for different toxic gases are defined in different ways.
OSHA permissible exposure limits are defined in three ways; by means of an 8 hour time weighted average (TWA), an instantaneous ceiling, and a short term exposure limit (STEL), calculated as a 15 minute time weighted average. Permissible exposure limits for gases and vapors are usually given in part-per-million concentration (1% = 10,000 PPM). The PEL for a particular gas may consist of one, two, or in a few (usually transitional) cases all three terms. You can't pick and choose which parts of the definition you are going to comply with: If a particular gas has a multi-part permissible exposure limit it is equally important to comply with all parts of the limit.
The OSHA (1989) permissible exposure limit for carbon monoxide consists of two parts, a "ceiling" of 200 PPM and a "TWA" of 35 PPM.
The OSHA (1989) permissible exposure limit for hydrogen sulfide is also a two part definition. The PEL for H_2S consists of an 8 hour TWA of 10 PPM, and a short term exposure of 15 PPM.
Biosystems instruments are equipped with three independent alarm set-points for each sensor installed; ceiling (instantaneous), STEL and TWA. With Biosystems instruments there's no guessing; the instrument automatically sounds the alarm whenever the concentration exceeds *any* part of the permissible exposure limit definition.