A Deadly Duo: Hydrogen Cyanide and Carbon Monoxide

By Firefighter William A. Staudt

The deadly effects of toxic smoke generated by fire is better understood today than in the past. Although there are many poisonous gases present in smoke, the combination of hydrogen cyanide (HCN) and carbon monoxide (CO) produces a lethal mixture that may cause immediate or significant long-term damage to an exposed member's health. This article aims to reinforce the logic behind the directive: "Wear Your Mask."

There is a reason why Firefighters cough or even retch when "taking a feed." Firefighters' bodies are being subjected to toxic substances and can tolerate only so much of these toxins. It is not uncommon to have a highly toxic concentration where one single breath may prove fatal. Paradoxically, the lack of visible smoke does not indicate a safe environment in which to breathe. Below-grade locations, enclosed rooms and areas not directly in contact with those affected by fire still may be contaminated.

Odorless, colorless CO is known as the *Silent Killer.* Its presence always must be suspected. A properly functioning CO meter must be present at all times to alert members accordingly.

Cyanide is one of the most lethal poisons known to man. Today, the most common cause of cyanide poisoning is domestic fires. This increase is directly attributed to the release of cyanide gas during the combustion process. Products that release cyanide gas during combustion include plastics, insulation, synthetic rubber, wool, silk and many other commonly found household items.

Vehicular and public transportation fires also may expose members to cyanide gas. Dumpster fires must be mentioned as well. Burning material will decompose unpredictably and release HCN in rates that will vary in concentration. Worldwide industrial consumption of cyanide is estimated to be 1.5 million tons per year. The development and manufacture of an endless stream of varied synthetics will continue. These compounds will contribute to fire loads, more intense heat and a toxic stew of deadly gas by-products.

Members may make the assumption that, in the future, far more Firefighters will be exposed to this perilous substance than in previous years. At this time, Haz-Mat units and Squads have HCN meters. They are used infrequently. However, when they have been used, these meters consistently indicate very high levels of HCN at virtually every fire. The initial alarm for the meter activates at HCN 2.5 parts per million (ppm).

The chemistry of hydrogen cyanide and carbon monoxide can be a complex subject when it comes to analytical explanation and will not be covered here. Quite simply, CO prevents oxygen absorption into the bloodstream. HCN prevents oxygen absorption at the cellular level. This one-two punch prevents oxygen perfusion, necessary for all aspects of body function.

FDNY protocol indicates that a reading of CO nine ppm or less is considered safe for habitation. Any reading greater than nine ppm is *not* considered normal. Concentrations of CO 10,000 ppm with a *one-minute* exposure will result in death. Much lower levels also will prove fatal, depending upon duration of exposure. Victims overcome by CO poisoning first will lose consciousness, suffer convulsions and then die, due to respiratory arrest. Their heart, however, may continue to beat for three or four minutes after their last breath.

It is important for members to recognize the signs and symptoms of respiratory difficulty in civilians, other members and themselves. Some indicators may include confusion, headache, lack of balance, gasping for breath and blurry vision. Do not procrastinate in seeking help.

Proper ventilation will help to disperse CO, which eventually will break down and become carbon dioxide (CO2). Compare this with HCN. Far more stable, HCN will remain in particulates and soot and thus on all our firefighting gear. Also, it is easily absorbed by our skin and mucous membranes. The short-term exposure limit recommended by the National Institute for Occupational Safety and Health (NIOSH) is HCN 4.7 ppm. The Environmental Protection Agency lists HCN 10 ppm as making an adverse impact in as little as 30 minutes.

The combined effect of CO and HCN exposure have both a short- and long-term detrimental effect that can kill individual cells in an organism. The cumulative, repeated exposure may result in chronic diseases of the heart and nervous system. HCN poisoning in low doses generally is recognized as a cause of permanent neurological damage. This is yet another good reason to have *all* personal protective equipment (PPE) periodically decontaminated.

FDNY members are properly geared up with personal protective equipment (PPE) and self-contained breathing apparatus (SCBA), as they battle this toxic and smoky fire at Brooklyn Box 33-2961, 222 Kings Highway/West 10th Street, December 30, 2008. Photo by Brooklyn Dispatcher Warren Fuchs (retired)

New technology brings with it new challenges. Our understanding of atmospheric gases in an immediately dangerous to life and health (IDLH) environment has improved dramatically in recent years. The presence of so many toxic compounds is now fact. The old smoke-eaters of yesterday have, for the most part, become part of firefighting lore. The "good, clean smoke" is a thing of the past, if it ever even existed. One thing is for certain. Today's fires bring today's smoke--a dangerous, debilitating, career-ending, life-shortening toxin that Firefighters will encounter often. When operating in a smoke-contaminated environment, every member always should consider the possible consequences to one's long-term health. Wear your mask!

References

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3. "Use Your SCBA for these Dangerous Inhalation Hazards," DiamondPlate video, February 14, 2017. ■

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