The Hazards of Carbon Monoxide

by Lieutenant Richard Curiel

Editor's Note: *While attending an intensive, one-week course of research, writing and developing lesson plans at the New York State Fire Academy in Montour Falls, the author chose the topic of carbon monoxide detector to obtain a better understanding of this tool, as well as insight into how carbon monoxide affects the body. Based on this research, he addresses some common concerns about carbon monoxide and shares this information with* WNYF *readers.*

What is carbon monoxide and how is it formed?

Carbon monoxide--known as CO--is an invisible, odorless, toxic gas that is released during incomplete combustion. Whenever any machine or engine is using or burning a fossil fuel or hydrocarbon--such as oil, natural gas or gasoline--CO is being released. Even when no machinery is running, but a product is burning--such as wood, paper, plastic, charcoal or almost any material that contains carbon--CO is being released as a by-product of incomplete combustion. Almost no carbon-based product burns with complete efficiency. Without going into detailed chemistry, when heat breaks down these hydrocarbons, the carbon atoms are released in the form of carbon monoxide gas.

BW Technologies
GasAlert Extreme CO Meter

Can carbon monoxide be detected without a CO detector?

There is no way of detecting this gas without some kind of instrumentation. However, there are some key indicators that alert Firefighters to CO gas in the environment. Heavy, black smoke is a clear indicator of smoke containing high levels of carbon and CO gas. Obviously, the more inefficient the burning--such as a smoldering fire--the greater the amount of CO that is being released. Don't be deceived; propane, natural gas and charcoal all burn cleanly, emitting very little smoke. Nevertheless, they all produce a significant amount of carbon monoxide gas. It is not unusual for a gas stove, which is in a tightly sealed room and being used for a considerable amount of time, to trigger an alarm on a CO detector.

Don't forget the symptoms of CO poisoning. The persistent or migraine frontal headache, nausea, appearance of drunkenness (without alcohol consumption), vomiting, sleepiness and lethargy are all telltale signs of possible CO poisoning.

Where is carbon monoxide likely to be found in a building?

Most Firefighters falsely believe that carbon monoxide only accumulates in basements. Heated gases, such as CO, will rise initially. However, when this gas cools, CO can be found almost anywhere within a structure or building. Its molecular weight is almost equal to that of air. It is slightly lighter than air and, therefore, over time, this gas will disperse itself equally throughout the room where it is being emitted. Furthermore, other factors may influence where this gas accumulates.

In high-rise buildings with numerous shafts and elevators, this gas can be pushed around and accumulate on almost any floor. In private dwellings, depending on the source of carbon monoxide and ventilation present, CO can accumulate near the source or in a remote location of least air pressure resistance. Keep in mind that in any below-grade area, such as basements or tunnels, Firefighters automatically are dealing with less ventilation and can have below-average amounts of oxygen. It is in these compromised areas that the presence of a moderate amount of CO gas quickly can become dangerous to life and health.

Why does carbon monoxide kill so easily?

This gas affects our bodies in two distinct ways: It prevents our bodies from absorbing oxygen. Secondly, it asphyxiates a victim without the person recognizing what is happening. It does this by not allowing the body's hemoglobin--which carries oxygenated blood and removes carbon dioxide from our system--to function properly.

Hemoglobin is the component that transports oxygen and removes the waste carbon dioxide from our lungs. Hemoglobin has a strong affinity for CO. It is approximately 210 times easier for hemoglobin to carry CO than it is to carry oxygen. In other words, your blood prefers to transport this lethal gas throughout its system.

Additionally, when the hemoglobin returns to the lungs to relieve itself of its waste, it does not release the CO and further compromises the respiratory system. Depending on the level of CO gas present, this process will continue until one either is removed from this contaminated atmosphere or sickness, unconsciousness and/or death occurs. Once exposure occurs, it can take up to several hours for our bodies to begin to release this gas from our lungs. Again, this is dependent on the oxygen that is present.

What is considered a dangerous level of CO?

This answer is not so simple because it depends on many factors: How many incidents did I respond to during my tour of duty? Did I travel to work through a tunnel during rush hour? Am I a cigarette smoker? Do I have factors that compromise my breathing, such as allergies, asthma or hyper-airway condition? If I am a woman, am I pregnant? These and many other factors influence how significant a low-level exposure might become.

The cigarette smoker will be symptomatic first, because he/she is constantly carrying CO in his/her blood. The pregnant woman has two people using the same oxygen supply. Remember that the effect of CO gas is cumulative and a low concentration over a long period of time can be dangerous. The National Institute for Occupational Safety and Health (NIOSH) handbook describes the Immediately Dangerous to Life and Health (IDLH) of carbon monoxide as 1200 parts per million (ppm). These IDLH calculations are based on a 30-minute time period. However, this does not mean that Firefighters can remain in an IDLH area for this amount of time with no adverse health effects.

How concerned should I be about the flammability of CO?

One of the properties frequently overlooked concerning this gas is its flammability. CO gas has a flammable range from 12.5 to 74 percent. To convert this percentage into parts per million equates to approximately 125,000 to 740,000 ppm. According to Battalion Chief Frank C. Montagna, Officer Development, with approximately 1.28 percent of CO in the air or 12,800 ppm, death can occur in one to three minutes. Remember, a fire area with high

Members are urged to review the following references:
- "Introducing the MSA Altair Multigas Meter," by Captain Carlos Vazquez, in the 1st/2009 issue of *WNYF*.
- *Responding to Routine Emergencies*, by Battalion Chief Frank C. Montagna.
- *Carbon Monoxide, The silent killer*, by Roy J. Shepard.
- *Carbon Monoxide and Human Lethality*, by Marcelo M. Hirschler.

CO readings will be extremely toxic and dangerous, long before it reaches the range of carbon monoxide flammability.

Can the GasAlert CO detector record the level of CO to which I was exposed?

The newer version of the GasAlert Extreme CO Meter has the ability to record data. These data can be retrieved later, which can identify how many ppm and for how long a member was exposed. This detector also has the ability to record any key action touched by the user. The data-logging feature records every stroke of a key; it will even record if the back light was illuminated.

At a recent incident, the Department was able to visually see the data-logging portion indicating when the Firefighter left the toxic environment and then re-entered. This information is being used and analyzed by FDNY's Safety Battalion to better understand CO and its effects on our bodies.

What is the best way to handle a CO incident/emergency?

Do not lose sight that Firefighters are searching for an invisible, lethal gas. They must find the source of this gas and not leave the building until the source is identified. Otherwise, the results could be devastating. Although the area must be vented, it may be wiser to slowly walk throughout an area, searching with the detector before ventilation begins.

Obviously, if civilians are present, interview them and ask some basic questions, such as:
- Do they or any member of the family have any ailments/symptoms?
- Have they been (or are they) cooking?
- Have they left the car warming/idling in the garage?
- Have they had any recent work done on their heating system?
- Have they recently opened a window?

Some initial actions that Firefighters should take include:
- If necessary, call a second unit to confirm meter readings.
- Get readings in adjoining apartments or buildings.
- Have someone account for all members of the family.

There has been a construction renaissance in New York City within the past several years. Almost every area of the City has experienced some form of revitalization. This can be in the form of garden apartments, condos, duplexes and one-, two- and multi-family attached homes, with garages located in the rear, alongside or underneath these dwellings. Where victims are symptomatic and there is no known source present, a diligent search must be made of these surrounding areas.

Remember, the source of carbon monoxide gas may be an automobile that is silently idling in a garage located several units away from where the call originated. The critical issue in dealing with carbon monoxide is identifying the source of this lethal gas. The GasAlert detector is one of the tools available to identify carbon monoxide gas. Ultimately, it is the Fire Department's professionalism and early intervention at CO incidents, which are responsible for saving a significant number of lives in this City.

About the Author...

Lieutenant Richard Curiel is a 19-year veteran of the FDNY. He is assigned to Haz-Mat Operations. Prior assignments include Ladders 130 and 26 as a Firefighter and Engine 15 as a Lieutenant. He is a Fire Instructor, Level Two, with New York State and National certification. He is studying Biology at Queens College. This is his first article for WNYF.

*(**Seelig**, continued from page 6)*

must be considered in planning an operation. Travel time to the pickup site, loading required equipment and boarding members onto the fireboat can result in unplanned delays.
- A reconnaissance onboard ship by FDNY Chief Officers prior to development of an operational plan and deployment of personnel is extremely important when dealing with a fire or emergency situation aboard a ship.
- Initial discussions with the ship's crew and/or agent are essential when dealing with a shipboard incident. Although officers aboard ships entering U.S. ports are required to speak English, language barriers could still exist. Boarding the ship, Fire Department members immediately should request to meet with the captain or chief officer and verify that all crew members have been accounted for. A ship's crew list should be requested and accountability of all members listed verified. A copy of the ship's crew list, along with the ship's fire safety plan, usually can be found in a weather-tight box adjacent to the gangway on either side of the ship. (See photo at right.)
- Shipboard operations tend to be very lengthy. Rotation of and plans for relief of members must be considered in the planning stages. Logistical considerations, including food and water for operating members, must be anticipated for prolonged operations.

The ship's fire safety plan usually is found in a weather-tight box, adjacent to the gangway on either side of the ship.

Conclusion

The off-loading of the burning coal onto the last barge finally was completed at 2100 hours on December 30, 2008, 27 hours after the initial notification by the Coast Guard on December 29. The extreme weather conditions encountered during the operation tested the stamina and determination of all members involved. The professionalism and adaptability of FDNY personnel resulted in the successful conclusion to this unusual, but challenging, incident.

About the Author...

Deputy Assistant Chief William Seelig is a 31-year veteran of the FDNY. He is the Chief of the Special Operations Command. Before becoming a Staff Chief, prior assignments included Chief of Rescue Operations and Division 6. He was an original member of the FDNY Incident Management Team, serving as an Operations Section Chief. He holds a bachelor's degree in civil engineering from Manhattan College. This is his second article for WNYF.