Carbon Monoxide Investigations--They May Not Be Routine Calls

by Lieutenant Christopher Flatley

As a company Officer, one of the more common alarms members respond to is a carbon monoxide (CO) alarm investigation. This may seem like a routine call, but it is not the time to be complacent. According to U.S. Product Safety Commission statistics, on average, 250 people die and 10,000 more are seriously injured from CO poisoning each year. These high numbers have prompted many jurisdictions, including New York City, to adopt carbon monoxide detector legislation requiring mandatory detectors in dwelling units.

The alarm assignment for a CO device activation is one engine and one ladder company; no Chief. This puts the initial decision-making in the hands of company Officers, whether just promoted or an Officer for 10 years. To make these critical decisions, Officers must know how to interview occupants, properly investigate the alarm and determine the source of the CO. They must be familiar with FDNY's operational guidelines and be able to take appropriate actions.

History

Home CO detectors differ greatly from their industrial counterparts. Initially, industrial units were complicated, expensive and lacked the sensitivity for the home environment. As detectors for home use gained popularity, their level of sophistication improved. The earliest home detectors were nothing more than a fiberboard card treated with a chemical that would change color if exposed to carbon monoxide. This was unacceptable in the home because the card had to be visually inspected and did not provide an audible alert for occupants.

The next generation of home detectors employed a bio-memetic technology. Bio-memetic detectors are designed to mimic the human body response to an exposure to CO. This gel sensor was an improvement over the fiberboard cards, but had its own drawbacks. It was designed to continually absorb an air sample; even low levels of CO could build up in the unit and cause false alarms. To reduce the false alarms, the detector was designed not to go into alarm until a time-weighted average was reached (see table below). The time-weighted average would put the detector in alarm more quickly at higher concentrations, while extending the time at low levels. It functions like a rate of rise heat detector. When a sensor had been exposed to CO, the bio-memetic gel would require many hours of exposure to clean air to reset. Basically, the sensor would have to *off-gas* to reset. These detectors will have wording to the effect, *remove to fresh air to reset*.

The next type of sensor designed for the home market is the metal oxide sensor. The tin-dioxide circuits in these units are more accurate and the most common used today. They continually monitor the air and provide a digital readout of CO concentrations. The alarm levels are based on the LCD readout. However, they are susceptible to *false positives* in that they can be set into alarm by exposure to carbon monoxide found in other gases, such as methane (natural gas) and propellants in household items, such as hair spray. The cumulative effects of these false positives can cause a detector's accuracy to stray up to 40 percent in six months.

The newest sensor technology is instant detection and response (IDR). It is an electrochemical sensor and becoming the industry standard for detection equipment. It has an accuracy of +/-3 percent and is not cross-sensitive to other gases, eliminating false positives. This new technology is increasing the market share in home-detection equipment, similar to the processor that is found in Gasalert personal CO monitors carried by FDNY members.

This technology is not without its drawbacks. One of the concerns is in the detector's ability to monitor air in high humidity. The detector has a filter medium that covers the sensor. When the filter is soaked with moisture, it may not sense accurately. This is akin to protecting yourself from smoke by breathing through a damp cloth. The moisture in a home can come from atmospheric moisture from rainfall or moisture generated from the steam from a shower or boiling water during cooking.

Dampening the filter medium can cause differences in the reading on the home detector and FDNY meters. This can occur if the assigned member is wearing the Gasalert meter under his/her bunker coat during hot weather. The member's perspiration can create humidity that can be trapped under the coat and cause the filter medium to become soaked to a point where the accuracy can be affected. The operating range for the Gasalert CO detector is 15 to 90 percent relative humidity.

Investigation

Since life and health are FDNY's first priorities, begin the investigation by interviewing the occupants. Are there any signs or symptoms? Were they home when the detector went off? If they were home all day and the detector just went off ask what they were doing during the day. This can provide clues. If they just arrived home and found the detector going off, it is reasonable to assume that they would not be showing signs or symptoms. Confusion is one of the early signs of CO exposure. If during the interview, the occupants are confused or unsure of answers, they may be answering the question by not being able to answer.

During the interview, do not ask leading questions, such as *Do you have a headache? Do you feel lightheaded?* If they think they were exposed, they will tell you they have those symptoms. Instead, ask *How do you feel?* Let them explain.

Look for signs in the high-risk populations. Small children and older adults may exhibit signs of CO exposure

This table is based on the ANSI/UL 2034-2005 standard for sensitivity (the parameters of the time-weighted average).

Carbon Monoxide Concentration and Response Times

Concentration (PPM)	*Response Time in Minutes*
70 +/-5	60-240
150 +/-5	10-50
400 +/-10	4-15

False Alarm--Carbon Monoxide Concentration Resistance

Concentration (PPM)	*Exposure Time (no alarm)*
30 +/-3	30 Days
70 +/-5	60 Minutes

Helpful Hints for Carbon Monoxide Investigations

Properties
- Colorless, odorless, flammable and toxic
- Vapor density slightly lighter than air; carried on convected air currents
- CO reduces the blood's ability to carry oxygen

Symptoms
- Low-level exposure--headache, dizziness, confusion, fatigue
- Medium-level exposure--vomiting, loss of consciousness
- High-level exposure--seizure, coma, brain damage

Operational Guidelines
- Begin metering before entering the building
- Locate the source; shut down the appliance
- Ventilate

PPE
- SCBA shall be worn at all CO investigations/used during CO emergencies

By the Numbers

Incidents
- Readings less than nine--evacuation *not* required unless symptoms present

Emergencies
- Readings more than nine or symptoms present
- Recommend occupants leave the area; potentially dangerous CO reading
- Ventilate to reduce CO before re-occupying

Greater than 100 or symptoms present
- Mandatory evacuation; potentially lethal levels
- Ventilate to reduce CO before re-occupying

Reports10-38
- *Code 1*--CO investigation--low battery, defective detector, unwarranted alarm

Note: When entered via MDT, the report will self-close and no other reports are required by NIFRS.
- *Code 2*--Detector activation--CO Incident readings one to nine ppm
- *Code 3*--Detector activation--CO Emergency readings higher than nine ppm
- *Code 4--No* detector activation--no detector present/detector present did not activate

more quickly than healthy adults. CO also will affect pets. If the family has been out all day and the pets were home, they may provide the best clues. Is the dog vomiting or listless?

Repairs and replacement of fuel-burning appliances can have problems during initial start-up, which may produce CO until final adjustments are complete. If the affected area has been vented before FDNY arrival, the source of the CO may not be evident. You may need to recreate the conditions as they were when the detector went off, closing windows, etc. If the room has been vented, it may take some time before the CO rises to detectable levels. Readings on any instrument should be verified by a second device to ensure accuracy.

While conducting the investigation, never forget your senses. Though CO is odorless, fumes that produce it may not be. For example, if the CO alarm is going off in the first-floor apartment and you enter the front door and smell the odor of an oil burner, it may indicate the heating equipment is malfunctioning. Odors of food can indicate someone was cooking on a defective stove. A properly functioning stove will have bright blue flames; any other color toward gold or yellow can indicate the stove is not burning with the proper air mixture, thus promoting incomplete combustion, which produces CO.

A smell of gas can indicate a leak in the gas piping to the stove. Remember false positives. Check for a natural gas leak behind the stove with the combustible gas detector (TIF 8800 or other device). A soap and water mixture applied to the piping will cause large bubbles to form at the point of the leak.

Know how to protect the members. Know the operational limits of PPE and when you *must* wear SCBA.

At some point, you must examine the detector. Do you know what the *chirps* mean? It would be impossible to explain every brand and model on the market. The detector itself will have a label on the back with a sticker to decode the chirps. This will allow you to determine if the device is in alarm, in need of a replacement battery or some other condition.

On the device you also will find a date of manufacture for the detector. Most brands now are guaranteeing their devices for five years--some longer--but recommending replacement at seven years. The older detectors may still be found in the field. They will have all the drawbacks previously stated and may provide the homeowner with a false sense of security.

Members are urged to review the following references:
- *Firefighting Procedures*, Haz-Mat 4, "Carbon Monoxide."
- *ABC 3-88*, "Utility Company Notification."
- *EMS CME*, July 2009, Article 1, "Molecular Killers."
- *NFPA Journal*, January/February 2008. "CO Deaths."
- *How Products Are Made*, Volume 4, "Carbon Monoxide Detector."
- *Gasalert Extreme Owners Manual*, page 12, Specifications.
- "CO Detector Activation--The New Nuisance Alarm?" by Lieutenant James T. O'Connor, in the 1st/2007 issue of *WNYF*.
- "Introducing the MSA Altair Multigas Meter," by Captain Carlos Vazquez, in the 1st/2009 issue of *WNYF*.
- "The Hazards of Carbon Monoxide," by Lieutenant Richard Curiel, on page 7 of this issue of *WNYF*.

Decision time

What do you do when FDNY meters verify the activation of the homeowner's device? What is the reading? How many people are involved? Are there signs or symptoms? Is the CO affecting a large nursing home, a high-risk population?

Any incident that has people displaying signs or symptoms requires notification for EMS and a Battalion Chief to respond. Advise the dispatcher of the CO readings and request a response from the local utility. The Public Service Commission requires utility companies to conduct an investigation when injuries are sustained from carbon monoxide where natural gas may have contributed to those injuries. This also can be a proactive measure since if members turn off the gas to any fuel-burning appliance, the utility must be notified anyway. This can expedite response.

Provide first aid

Individuals suspected of being exposed should be moved to a clean environment. Administer oxygen and monitor vital signs. Administering a high flow of oxygen through a non-rebreather mask will reduce the time it takes to remove the CO from the blood stream by a factor of five. It normally takes five hours to reduce the level of CO in the body by half, when the person is breathing ambient air (21 percent oxygen). When breathing oxygen at 100 percent--five times that of ambient air--it will reduce that time to one hour.

In the pre-hospital setting, it is difficult to determine the CO level in a person's blood from symptoms alone. Individual tolerance can vary and assessment can be subjective. EMS duty Captains carry a Massimo RAD 57, a CO monitor that clamps on the finger, similar to a pulse oximeter. The device will digitally display the percent of CO in the patient's blood.

Most decisions Officers will make at these alarms will not be dramatic, but not without consequence. Consider the young family who has called late at night when the detector has awakened them. You are unable to clearly determine the source of the CO, even though you suspect the boiler. Do you shut down the boiler, turn off the oil or gas, notify the utility and make them get a licensed plumber to service the boiler before they restart the unit? Or, do you tell them if the detector goes off again, call us back?

As fire Officers, people put their lives in our hands everyday. This is just one more example of why we need to be professional, know our job and exhibit the expert judgment to handle crisis. The routine call may turn out to be anything but routine.

About the Author...

Lieutenant Christopher Flatley is a 20-year veteran of the FDNY. He is assigned to Tower Ladder 21. Previously, he was assigned to Ladder 2. He is a nationally certified Fire Instructor I and has written articles for several other fire service publications, including Fire Engineering. *He writes frequently for* WNYF.