

INSTRUCTOR GUIDE

TOPIC: FIRE DEPARTMENT RESPONSE TO CARBON MONOXIDE INCIDENTS

TIME REQUIRED: 2 TO 3 HOURS

MATERIALS: Baltimore County Fire Department SOP for Carbon Monoxide Incidents

Baltimore County Fire Department Form: Check List

Baltimore County Fire Department Form: Notice of Finding

MOTIVATION: With the recent deaths of families because of CO incidents that are making the paper, we the fire service need to understand what Carbon Monoxide is and how we should handle an incident involving Carbon Monoxide Detectors to put the public mind at ease.

OBJECTIVE (SPO):

OVER VIEW:

CO: The Invisible Danger

CO Detectors, Operating Principles, Installation Limits

Responding to CO Detector Activation

Review of Carbon Monoxide Meter

DEPARTMENT RESPONSE TO CARBON MONOXIDE INCIDENTS

SPO 1 – 1: The student will demonstrate how to handle a Carbon Monoxide Incident

Enabling Objectives

- EO – 1: The student will be able to identify how Carbon Monoxide affects the Human Body.
- EO – 2: The student will be able to explain the operating principle and Installation limits of Carbon Monoxide Detectors.
- EO – 3: The student using the worksheet provided will be able to demonstrate the response to a Carbon Monoxide Incident.
- EO – 4: The student will demonstrate using a Carbon Monoxide Detector

I. CO: The Invisible Danger

A. What is CO and who is at risk

1. Colorless, odorless, tasteless, non-irritating toxic gas
 - a. CO is a poison
 - b. Can be deadly at high levels
 - c. At low Concentrations, CO can go undetected and Contribute to nagging illnesses.
 - d. It can Compound pre-existing health problems and often times go un-blamed in premature deaths.
2. CO poisoning is the leading cause of accidental death in the u.s.
 - a. 1500 accidental deaths
 - b. 10,000 illnesses annually
3. CO enters the body by respiration and reduces bloods ability to transport oxygen to the body
 - a. Inhaled CO is absorbed by the oxygen carry portion of the blood hemoglobin" (COHb)
 - b. CO and hemoglobin Combination is known as "carboxy hemoglobin"
 - c. CO is 240 times more likely to be absorbed than O₂
 - d. Smaller amounts of CO in the air can rapidly increase the COHb levels
 - e. CO replaces O₂ in blood depriving body of O₂
 - f. Can be fatal when COHb reaches 50 to 70 %

B. CO facts

1. It can injury or kill before its presence is recognized
 - a. Can pose a danger in new homes as well as old home
2. CO from appliances can reach dangerous Concentrations if proper steps are not taken
 - a. Charcoal-burning appliances - up to 200 ppm
 - b. Gas ranges - Cold 800 ppm - operating temp - 400 ppm
 - 1) CO normally dissipates to a lower level throughout house

C. It is not safe to run an automobile in a garage with the garage door open

1. Home may be under negative pressure and pull CO into the home

D. Some people are at a higher risk than other

1. Infants have higher respiration rates and greater need for oxygen than adults
2. People who may be oxygen-deprived, such as COPD and people with heart problems

E. Why is CO dangerous

1. Highly toxic
2. Undetectable without special instruments
3. Provides no early warning signs of its negative effects
4. Suffocates by displacing oxygen in the bloodstream
 - a. Low level CO poisoning can mimic flu symptoms

F. Where does CO Come from

1. CO is a by-product of Combustion
2. It can result from many different areas
3. In properly vented homes CO is safely dissipated and vented outside
4. Weatherization can allow CO Concentration to increase
5. Inadequate air supply can cause reverse stacking

G. Symptoms of CO poisoning

1. Mild - COHb < 15 – 20 %
 - a. Slight headache, nausea, vomiting, and fatigue
 - b. 1986 study of emergency room patients found that 24% of patients reporting flu symptoms had low level CO poisoning
2. Medium – COHb 21 – 40 %
 - a. Severe throbbing headache, drowsiness, Confusion, and fast heart rate
3. Extreme – COHb 41 – 59 %
 - a. Unconsciousness, Convulsions, heart & lung fatigue, brain damage and eventually
 - b. Medical experts estimate that 1/3 of all cases of CO poisoning go undetected, and that 1/3 of survivors may have lasting memory deficits or personality changes
4. Fatal – COHb > 60 %
 - a. Death
5. Unborn babies can be at risk when exposed to lower levels of CO
 - a. Medical evidence suggests that lower level exposure to CO, even at 20 ppm can be hazardous to children, infants, the unborn, the elderly, and those with heart or lung disease

6. Extreme CO poisoning can disorient and impair motor skills
 - a. This may affect a person's ability to open doors or perform other simple tasks
7. Treatment for CO poisoning
 - a. Remove victim to fresh air and give 100% O₂ through tight fitting face mask
 - b. Half life of CO is 300 minutes. Breathing pure O₂ reduces it to 80 minutes
 - c. Hyperbaric O₂ further reduces it to 23 minutes

II. CO Detectors, Operating Principles, Installation Limits

A. CO exposure levels and detector alarm standards

1. Federal exposure standard
 - a. There is no Consensus on acceptable exposure levels to CO. The various exposure thresholds set by different regulatory agencies reflect differences in the purposes of their regulations
2. Ambient Condition
 - a. EPA standard for ambient air is 9 ppm/8 hours
 - 1) Several us cities exceeds this threshold two or more times a year
3. Measuring CO
 - a. Expressed in parts per million over time
 - b. Higher the Concentration, the shorter the time period needed

B. Underwriters laboratories standard 2034

1. General features
 - a. Must pass 37 tests of safety, reliability and performance
 - b. One test requires that the detector activate when exposed to specific levels of CO
 - c. The higher the Concentration, the shorter the time allowed for the detector to activate
 - 1) Example 100 ppm for 20 minutes may have no effect. Four hours exposure to 100 ppm may cause headache.
 - 2) Example 400 ppm for 35 minutes may cause headache, while a 2 hour exposure would be fatal.

C. All detectors must have a silence button. Pushing it will silence the alarm for four to six minutes. If Concentrations stay above 70 ppm it will alarm again in six minutes.

D. New detectors only have two alarms – full and trouble

1. Carbon monoxide Concentration and response time
 - a. 70 ppm within 60 -240 minutes
 - b. 150 ppm within 10-50 minutes
 - c. 400 ppm within 4 – 15 minutes
2. False alarm – carbon monoxide Concentration resistance specifications
 - a. 30 ppm - 30 days no alarm
 - b. 70 ppm – 60 minutes no alarm

E. Reliability

1. UL also conducts periodic unannounced factory inspections to select additional units for testing

F. Sensor technology and operating principles of CO detectors

1. General
 - a. Designed to Continuously monitor
 - b. Hardwire only, battery only, or hardwire with battery backup
 - c. Two types - biomimetic or semiconductor

G. Biomimetic

1. A biologic system
 - a. Mimic life
2. Refer to as a gel cell
 - a. Because of the translucent disk used in the sensor
3. Molecularly engineered synthetic hemoglobin
 - a. Mimics the reaction of natural hemoglobin to CO because it is designed to form a molecular keyhole that only CO can fit
4. As CO attaches to the hemoglobin the disk darkens
5. Led monitors the degree of optical change
 - a. When the concentration of CO on the disk reaches the activation threshold, the detector activates
6. Sensors do not accumulate CO
 - a. The sensors attract and discharge CO at the same time, but discharge rate is slower than the pickup

- b. CO half life is the same for both human body and the sensors, about five hours
 - 1) Example: a person who was exposed to CO and has a COHb level of 20%. After being in fresh air for five hours, the person's COHb level will be 10%
 - c. Depending upon CO concentration and exposure period, cleansing may take several hours
7. The overall life expectancy of the detector itself is 10 years

H. Semiconductor

- 1. Electrically-powered sensing element
 - a. Monitored by an integrated circuit, or computer chip
- 2. Majority use tgs-203 gas sensor
 - a. Sensor is highly selective to CO
 - b. Sensing element is a thin layer of tin dioxide that Covers a ceramic base
 - c. Wires on the same circuit are embedded into each end of the ceramic
 - d. The ceramic base creates an open circuit and the tin dioxide maintains an electrical Continuity between the wires
- 3. Attracts O₂ and CO
- 4. Increases the electrical resistance
- 5. CO reduces the electrical resistance
- 6. The lower the resistance, the higher the CO
- 7. Humidity can increase the sensitivity

I. Common installation practices

- 1. There are no installation standard
- 2. Recommendation depend on the type
- 3. CPSC - one outside sleeping areas
- 4. Most recommend one for each level and bedroom
- 5. Follow manufacturers instruction
- 6. Should be placed in every room where people spend a lot of time

J. Common installation problems

- 1. Too close to Cooking and heating appliances
- 2. Common areas of multi-family dwellings
- 3. Very cold or very hot areas

4. Dead air space
5. Locations where the detector is obstructed
6. Path of turbulent air from a ceiling fan
7. Locations where they accumulate grease and spots
8. Invented rooms with cleaning supplies and other Contaminants
9. On switched electrical outlets

III. Responding To CO Detector Activation

A. Dispatch, Response and EMS Considerations

1. Emergency vs. Non Emergency response
 - a. CO detector - 1 engine and the closest unit with a CO monitor – non-emergency response
 - b. CO detector with injury - 1 engine, 1 medic unit and the closest unit with a CO monitor - emergency response
2. Dispatch Considerations
 - a. Dispatch questions
 - b. Advice to occupants
3. Fire department response goal
4. Potential objectives
5. Fire Department response considerations
6. Assessing response capabilities
7. EMS Considerations

B. Investigative techniques and gas detection instruments

1. Consider fire fighter safety
2. Interview occupants
3. Determine Condition of home prior to detector activation
4. Create a worst-case scenario
 - a. If CO detector is activated, evacuate the building
 - b. If entering a building with a activated detector full protective equipment including SCBA will be worn
 - c. Do not ventilate the building until a functioning CO monitor is on the scene
 - d. If not already dispatched request EMS if any signs or symptoms are exhibited by any occupant

- e. When monitor is available, the crews will attempt to locate the source - if monitor alarms at any time, SCBA will be worn
- f. If determine an appliance is malfunctioning and producing CO, shut it down. If gas fuel BG&E should be requested. For other appliances, the appropriate qualified service technician should be requested by the homeowner
- g. Once source is located, start ventilation
- h. Complete notice of dangerous situation - carbon monoxide alarm
 - 1) Will help IC and homeowner with established guidelines for CO response
- i. Pregnant residents should be transported to hospital or, as minimum, to be examined by a physician, if signs or symptoms of CO are exhibited

5. Checklist

- a. Companies responding to a CO alarm shall use the CO Checklist to assist them in their investigation
 - 1) Check list is to assist in establishing the cause and origin of the CO
 - 2) It will also be used to develop a tracking system for CO incidents

6. Notice of finding

- a. Notice of dangerous situation - carbon monoxide alarm
 - 1) Less than 10 ppm: advise the homeowner that they should check the CO detector. If it activates again call 911.
 - 2) Over 10 and less than 100 ppm: advise the homeowner that we have detected potentially dangerous levels of CO. We recommend that you leave your home immediately. It is not safe until repairs are made.
 - 3) Over 100 ppm: advise homeowner we have detected potentially lethal amounts of CO in their home. They are to remain out of their home until the source has been identified and shut down, and the home has been well ventilated.
- b. Important to discuss the report with the occupant and advise them of action necessary to mitigate the CO problem
- c. One Copy for occupant, one to records, and one for station Copy

C. Testing and returning CO detectors to service

1. Biomimetic detectors

- a. Self testing
- b. Trouble alarm - one short beep per minute
- c. If not sounding - push test button
- d. If sounding - remove sensor pack
 - 1) May need as little as 1 hour
 - 2) Or may need 2 to 48 hours

2. Semiconductor detectors

- a. Self testing
- b. Trouble alarm - one short beep per minute
- c. If not sounding - push test button
- d. If sounding - push test button
 - 1) Detector should reset itself, if not detector needs to be replaced

IV. Review of Your Carbon Monoxide Detector

A. Review the following terms

- 1. Calibration
- 2. Field Test/Bump Test
- 3. Response Time

B. Operation the Meter

- 1. On/Off
- 2. Zero Calibration
- 3. Back Light
- 4. Clearing the Peaks

V. Summary

- A. CO: The Invisible Danger
- B. CO Detectors, Operating Principles, Installation Limits
- C. Responding To CO Detector Activation
- D. Review of Your Carbon Monoxide Detector