Carbon Monoxide
and
Explosive Gas Detection

Blair Ames
Montgomery-Ames Associates
Carbon Monoxide Detection

This paper discusses the topics in the following list:

- CO Poisoning
- Smoke, Ionization, and CO Detection during a Fire
- CO and Combustible Gas Detectors
- Detector Testing
- CO and Gas Detection Wiring
- Placement of Detectors
- Central Station Response

CO Poisoning

Carbon monoxide is an odorless, colorless, tasteless gas weighing 1.02 specific gravity of air. The following chart called the “Death Chart” is compiled by OSHA and other studies. If a person breathes CO at high enough parts per million (ppm) over more than two hours, they will die. (Figure 1)

![Figure 1. Carbon monoxide danger levels](image)

Carbon monoxide bonds with hemoglobin in the blood stream and replaces oxygen. It is one hundred times more adhesive to hemoglobin than oxygen. Normally, after feeding the cells with oxygen, the body pumps blue blood to the lungs and when it becomes oxygenated, the blood becomes red. Hemoglobin exposed to CO becomes carboxyhemoglobin and is pink. The cells are unable to remove the CO in the blood. (Figure 2)
Poisoning occurs by breathing CO, which increases in the bloodstream until no hemoglobin is available for transfer of oxygen, and the victim dies due to a lack of oxygen. The heart accelerates to try to offset the lack of oxygen, and heart attacks may also be induced.

There are many other short- and long-term effects if the person survives. Initially they experience physical symptoms such as headache, nausea, vomiting, pain, and dizziness. Cognitive and memory damage can occur including attention, multi-tasking, and short-term memory problems. Sometimes affective disorders, (emotional/personality effects) for example, irritability, anxiety, and lack of motivation are a result. Exposure to CO can also result in sensory and motor disorders that affect vision, hearing, co-ordination, speaking, eating, and gross neurological disorders such as seizures and tremors.

Smoke, Ionization, and CO Detection during a Fire

During the beginning stages of a fire when there is low heat and energy, there are incomplete particles of combustion resulting in CO and large smoke particles. During the course of the fire, increasing heat and energy allow complete combustion, and ionization occurs and produces CO2 and C+ (ion) ionized carbon particles.

A time-weighted average of exposure based on hemoglobin toxicity is required for CO detectors. There are two types of smoke detectors—ionization and photoelectric detectors. The change in voltage due to increased ions sets off ionization detectors. Smoke particles obscure and reflect light to set off photoelectric detectors. During the early stages of a fire, carbon monoxide detectors sense the incomplete combustion of carbon in CO.

The following chart shows approximate increases and decreases only. (Figure 3.)
Detection during incipient stages of a fire:

CO detectors and photoelectric detectors respond to the early CO concentration and large particles due to incomplete combustion.

Ionization detectors respond later as the temperature increases and results in complete combustion with CO\(_2\) and ionized C+ particles.
There are two types of CO and combustible gas detectors—chemical and electronic. Chemical detectors are electrochemical or photoelectrochemical. Electronic detectors use an SNO₂ metal oxide TGS sensor.

The electrochemical sensors conduct electricity based on exposure to CO. The driving force is a chemical reaction that provides increased conductivity with increased CO. These sensors consume little power. Local A.C. CO detector testing consists of pushing a test button to insure the buzzer is working. System detectors require use of test gas.

Photo electrochemical sensors change color by darkening and obscure light from an LED to indicate exposure to CO. These are also good for wireless transmitters and battery operated.

Today OSHA compliant ventilation systems operate at 35 or 50 ppm for fan exhaust control, fresh air purging and 100 ppm for alarm evacuation to prevent sickness of building occupants. The UL compliance for life safety at 70 PPM over 1.5-2 hours and OSHA’s standard of 50 ppm over 8 hours is to prevent accidental death at 10% blood saturation.

The manufacturers of chemical residential CO detectors have had a history of nonperformance and recalls.


**Detector Testing**

Ionization and photoelectric detectors are tested with calibrated smoke. Some Chemical and all Electronic CO detectors are tested utilizing manufacturer-provided calibrated gas canisters that typically provide 500 ppm for functional testing of and a certified 200 ppm of Gas for sensitivity testing and recalibration with a measured CO exposure, this tests the functionality with unmeasured Gas and sensitivity and recalibration is done with a calibrated gas in accordance with NFPA720 2009 edition. Explosive Gases are functionally tested, sensitivity checked and recalibrated at the lower explosive limits (LEL) with Gas test kits calibrated in accordance with Gas industry Standards.

This can be done on a maintenance schedule following NFPA guidelines for testing smoke, ionization, and heat detectors on the fire alarm system. The NFPA standards for system detector testing are as follows. See 7-3.2.1. (Table 1)
7.3.2.1* Detector sensitivity shall be checked within 1 year after installation and every alternate year thereafter. After the second required calibration test, where sensitivity tests indicate that the detector has remained within its listed and marked sensitivity range (or 4 percent obscuration light grey smoke, if not marked), the length of time between calibration tests shall be permitted to be extended to a maximum of 5 years. Where the frequency is extended, records of detector-caused nuisance alarms and subsequent trends of these alarms shall be maintained. In zones or in areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed.

To ensure that each smoke detector is within its listed and marked sensitivity range, it shall be tested using either:

(a) A calibrated test method; or
(b) The manufacturer’s calibrated sensitivity test instrument; or
(c) Listed control equipment arranged for the purpose; or
(d) A smoke detector/control unit arrangement whereby the detector causes a signal at the control unit where its sensitivity is outside its acceptable sensitivity range; or
(e) Other calibrated sensitivity test method acceptable to the authority having jurisdiction.

Detectors found to have a sensitivity outside the listed and marked sensitivity range shall be cleaned and recalibrated or replaced.

Exception No. 1: Detectors listed as field adjustable shall be permitted to be either adjusted within the listed and marked sensitivity range and cleaned and recalibrated, or they shall be replaced.

Exception No. 2: This requirement shall not apply to single station detectors referenced in 7.3.3 and Table 7.2.2.

The detector sensitivity shall not be tested or measured using any device that administers an unmeasured concentration of smoke or other aerosol into the detector.

7.3.2.2 Test frequency of interfaced equipment shall be the same as specified by the applicable NFPA standards for the equipment being supervised.

7.3.2.3 For restorable fixed-temperature spot-type heat detectors, two or more detectors shall be tested on each initiating circuit annually. Different detectors shall be tested each year, with records kept by the building owner specifying which detectors have been tested. Within 5 years, each detector shall have been tested.
Field Test Procedures

CO Functionality Test with =>500ppm and => 10LPM

1. Quickly press the TEST/RESET button 5 times. The buzzer will do a quick double beep and the LED will flash Amber alternating with a pause. The units will remain in this mode for 5 minutes or until it passes the quick test.

2. Aim the nozzle of the aerosol can at the buzzer grate area and press for 4 to 5 seconds (Fig. 1).

3. Wait for a few seconds. The LED should blink Green rapidly and the buzzer should double beep every 15 seconds indicating a pass of the quick test. If this does not occur, see CM-E1 TROUBLE INDICATOR section.

4. Press the button once to return to normal sensing mode.

CO Sensitivity Test with 200ppm CO and 0.2LPM regulator

1. Assemble the gas, regulator and CM-E1 test hood if this has not already been done.

2. Quickly press the TEST/RESET button five times. The buzzer will do a quick double beep. Hold the button down for three seconds. The LED will start to slowly blink Amber.

3. Lift the front plastic on the CM-E1 until the buzzer is showing (Fig. 2).

4. Insert the CM-E1 test hood onto the end of the sensor just below the buzzer with the printed side of the hood facing the buzzer (Fig. 3).

5. Turn on the gas. The LED should start rapidly blinking Amber once it has started to respond to the gas.

6. Wait for the Green LED to flash rapidly and a double beep from the buzzer every 15 seconds. If this does not occur, see CM-E1 TROUBLE INDICATOR section.

7. Press the button once to return to normal sensing mode.
The single gas handheld detector is an example of a gas sniffer that protects against hazardous levels of gases even in extreme conditions. (Figure 7) This CO sniffer can record instantly or CO levels over a 24-hour period for downloading to a computer for recordkeeping. This is used by first responders to verify the hazard and presence of toxic gases. The 24 hour CPU interface and chart logging feature can verify high buildup of CO in a parking garage at night for confirmation that alarms generated by the detectors were real and the CO was present in the building.

**CO and Gas Detection Wiring**

The CO and gas detectors are connected to a conventional or addressable initiating loop to activate a supervisory trouble condition, which will be transmitted to the central station or directly to the fire department. Individual identification of the detectors will allow the operator to provide scripted pinpoint instructions either to the client or the fire department or both. The following diagrams show typical alarm connections for a 24-volt Macurco gas detector to an alarm panel and a point addressable module (4W) for reporting the type of detector and location to a central station.

**Figure 8. Diagram of an Carbon Monoxide system detector electrical interface to a fire alarm system**
UL Listed Gas Detector for connection to a Fire alarm panel

GD-2A

- Detects heating gases: Propane (LP), Natural (Methane),
- SPDT alarm and N.C. Trouble relays
- Can be self-restoring or latching
- Electronic sensors: No maintenance or recalibration
- Temperature compensated
- Simple installation and operation
- Fail safe system: Supervised sensor
- Ignition protected design

TYPICAL CONNECTION OF TWO GD-2A TO AN ALARM CONTROL PANEL

Mechanical GD-6 or CM-6 direct connection for control of Exhaust fans or Shut off valves

Two Set point relays the lower set point for Fan & Valve control the higher set point for alarm and evacuation
Control wiring diagram for Control of Valves or Fans by
The 6 series of Detectors

NORMAL ONE DETECTOR, ONE GAS VALVE INSTALLATION
The Gas Detector mounts low for propane, butane, LP gas; high for natural gas.
See Installation and Operating Instructions.

TWO GAS VALVES, ONE DETECTOR INSTALLATION.
See installation and operating instructions. The fuse in the 4ST GVC may be replaced
with up to a 6 Amp fuse type.

ONE GAS VALVE, MULTIPLE DETECTORS INSTALLATION,
(Three Detectors Maximum).
See Installation and Operating Instructions.

GD-6 USED BELOW GRADE
TO EXHAUST UNBURNED LP
GAS PER UNIFORM
MECHANICAL CODE.
Section 304-5, 1997.

Relay and Fan must be mounted at or near the ceiling.
Fan must be of Squirrel Cage type with
inlet ducting and exhaust separate from
motor. Suggested fans:
Granger 4CB17
McLean Engineering 412
GD-6 mounts centrally near gas
appliance, six inches above floor.
The exhaust duct hose extends from
the fan to the floor near the gas
appliances.

If the installation is in an area of frequent or prolonged power outages, an electronic re-ignition system might be installed on the furnace.
(Loss of power shuts off the gas with this GD-6 detection system.) Propane re-ignition systems such as those by Honeywell, Roberts, and White Rodgers are available for propane furnaces.

7/04
Placement of Detectors

Carbon monoxide detectors generally should be mounted at breathing level four to six feet above the floor. However, ceiling mounting can be done, as CO has a small molecular structure, is equivalent to normal air weight (specific gravity) and disperses quickly and evenly within an occupied area. Ceiling mounted CO detectors mounted above 9 feet should be placed 30’ on center.

Wall mounted CO detectors at breathing level with an unobstructed passageway can be mounted 60’ on center. The Area of danger for CO inhalation is at 3’ sleeping and 4-5 feet where people breathe in the toxic gas. Ceiling mounting at 5-10 feet above the danger breathing zone requires a higher concentration of detection as CO quickly dissipates. CO dispersion is a volumetric calculation with initial high concentration at the supply vents.

CO Inhalation occurs a 4-5 feet above the floor for awake and 2-3 feet for sleeping

Explosive gas detectors are mounted based on the respective specific gravity of the gas detected. 

IE: Hydrogen Detectors are mounted on the ceiling

NFPA 720 for system CO detection under UL 2034 and UL 2075 for system Gas detectors mandate central system battery backup with supervised power and wiring. In a similar manner to conventional or addressable smoke detectors, CO detectors can be placed in apartment units for exact CO location identification and response or on a floor zone of detectors. Testing and maintenance procedures for all life safety detectors in a building can be uniform.

A certified installer should connect system detectors reporting to a fire department or a central station for prevention of false alarms. Because of the time-weighted poisoning effect, carbon monoxide should be uniquely qualified as a hazardous material with professional responses differing from smoke and heat detectors, explosive gas detectors, etc. The accelerated test mode feature allows for a quick test response to verify detector operation with the unmeasured test gas. The measured test gas verifies that the detectors work at the specified gas detection set points in Parts per Million (PPM) as required and if out of range can be recalibrated in the field to work at the mandated set points.

Residential smoke detectors and CO detectors serve as an early warning service in the apartment with units purchased at discount stores. Store bought CO detectors without the UL 2075 listing should not be system connected. These sensors can be Battery or AC interconnected in the apartment not to a central station.

UL 2034 and UL category CZHF apply without UL 2075. See Appendix 2.
Central Station or Fire/EMT dispatch response

Central/Fire EMT station response and actions are important for correct follow through by professionally trained and certified responders. A scripted HAZ-MAT response should be provided by the central station operator or fire department dispatch center. (See Appendix A) During a CO alert or alarm, personnel should be evacuated and tested with a CO Stat (see Appendix 3) Occupants exposed to CO should be put on oxygen immediately and then when tested with a high CO STAT taken to a hospital with a hyperbaric chamber. (Figure 9)

(Figure 9) Hyperbaric chamber for treatment of Carbon Monoxide victims

Response to Carbon Monoxide Alarms

The windows should remain closed if possible to safely trap the CO to help the first responders determine the origin of the CO before people are allowed to return to the building. The fire department EMT’s should enter the building wearing a breather pack and be equipped with a (Figure 7) gas handheld detector. The EMT’s with the handheld can determine the source of the Carbon Monoxide, alert the burner repair service and determine if the occupants are at risk returning to the building for additional CO exposure.

Response to Explosive Gas

Where extensive gas-burning appliances are present, explosive gas detectors that detect propane at the 20% lower explosive limit (L.E.L.) should initiate evacuation of personnel, opening of windows to prevent an explosion and a response by the gas company for shutoff of gas. Automated control systems with UL 1481, UL 2075, FTAM listed Gas detectors may shut off the gas valves and turn on ventilation fans as well as notify the remote central station or receiving station of the presence of explosive gas in the building. (See Appendix 2)

In locations where people are not present, the fire department should not enter until the gas company has verified, stopped, and cleared the premises of propane or other detected explosive gas. The fire department may dispatch specialized fire fighting vehicles with FOAM or other designated agents and procedures to fight the potential threat specifically suited for the site industrial hazard. A scripted HAZ-MAT response is again appropriate with handheld gas detection determining the leak and shutoff requirements. (See Appendix 1)
CO and Gas Detection point ID addressable transmission equipment

If a system electronic CO detector or explosive gas detector is placed in alarm, a unique ID should be sent to the central station or municipal receiver for a CO or explosive gas scripted response. UL 2034 and UL 2075 apply to Carbon Monoxide, UL 1481 and UL 2075 apply to Explosive gases for transmission via UL listed 864 or 925 control panels in accordance with the UL category FTAM.

The Keltron point-specific digital dialer for direct telephone connection is an example of point IDentification.

(Figure 10) This unit transmits unique point ID addressable fire alarm, CO, explosive gas, supervisory and trouble signals by SEA formats to the central station and municipal receiver.

(Figure 10) Keltron Telephone and Radio Intelligent point addressable Transmitters

Keltron’s innovative DataTap™ is an example of a radio interface that enables a point-specific fire alarm, Carbon Monoxide, explosive gas detection, supervisory signals, and trouble signal transmission to the central station or the fire department. An intelligent link from the fire alarm control panel (FACP) to Keltron's active network radio subscriber units, DataTap™ converts serial FACP data into point-specific alarm information that is received and transmitted through the radio subscriber unit to the monitoring operator at a remote location.
Dialer reporting

Contact ID Dialer reporting takes the following format:

# 151 Gas Detected Alarm-Gas Detected

# 162 Carbon Monoxide Detected Alarm

CCCC Q EEE GG ZZZ

CCCC = customer (subscriber account number)

Q = event qualifier, E = new event, R = restore

EEE = event code

GG = partition number, 00-08 (always 00 for non-partitioned panels)

ZZZ = zone ID number reporting the alarm (001-099), or user number for open/close reports.

SUBSCRIBER ID # XXXX

EVENT QUALIFIER   Event or Restore E or R

EVENT CODE* 000

151 = Gas Detected 162 = CO Alarm

PARTITION # 00

ZONE OR USER # C000 or U000

Municipal

Suggested Coded Signal output from an Electronic Master Box

IMSA 4 code indicates Carbon Monoxide - Site Code – pulse 4

IMSA 2 code indicates Gas Detected - Site Code/Danger Code 2

The major benefit of City Master Box is that by monitoring multiple outputs from an existing fire panel and allowing the transmission of multiple signals, it enables the fire department to receive alarms by zone and differentiate among alarms, troubles or supervisory signals, increasing the accuracy and speed of their response.
Appendix 1

Fire and Gas Scripts for a Central Station
Courtesy of Wayne Alarm, a UL/FM Central Station

FIRE (FIR) (Residential Fire)

Explaination: This is a signal sent from the premises alerting us to a possible fire condition.

Response Plan: The Monitoring Center will call the premises unless in a dispatch-immediately city or otherwise noted in account and attempt to abort the alarm. If the premises number is busy, there is an answering machine, no answer, or if no ID is given, we will dispatch the fire department and notify the call list.

Procedure: Hit Enter to retrieve the signal from the traffic screen, check comments and history (ALT-F3, ALT-F4, ALT-F6) to be certain alarm is verifiable. (Some cities require dispatch immediately on all fire alarms.) Verify at premises by picking up a phone line and hitting F2 to autodial the premises, unless comments indicate otherwise. Per NFPA 72, which is the accepted code, we attempt to ask the subscriber for their password or abort ID and their name. If this ID is not provided or incorrect, we proceed to dispatch the fire department. If the subscriber says that it is not necessary but does not have the ID, be sure and get their full name. Let the fire department know who is there and that although they said there was no fire, you are dispatching because they did not have ID. If the alarm is not verifiable, then proceed to FIR (Commercial Fire) below for the continuation of procedure.

Possible Causes: Actual fire. False alarm due to cooking smoke, shower steam, dirt in the detectors, construction dust, or possible alarm malfunctions.

Suggested Operator Script:

VERIFY: Good (morning / afternoon / evening), this is ____ alarm company calling. Do you need the fire department? Can I have your name and password?

If ID has not been provided or incorrect, proceed to FIR (Commercial Fire) for continuation of operator script.

FIRE (FIR) (Commercial Fire)

Explanation: This is a signal sent from the premises alerting us to a possible fire.

Response Plan: The Monitoring Center will dispatch the fire department immediately per NFPA/FM/UL regulations unless the subscriber has notified us otherwise in writing and this has been noted in the account comments. If the premises are located in a dispatch-immediately city, then the letter to verify must come from the fire department as well as the subscriber and both must be noted in account comments.

Procedure: Per UL/FM regulations, all commercial fire alarms are dispatched immediately! If municipality does not require immediate dispatch, subscriber may request in writing, fire alarm verification, at which point we will follow the guidelines for residential fire verification. Otherwise, fire alarms will be dispatched immediately. Hit Enter to retrieve the signal from the traffic screen and check comments and history (ALT-F4/ALT-F3/ALT-F6). Pick up a phone line and hit F2 to dial the fire department. AFTER DISPATCH: Either the premises or the subscriber call list or both are called to notify a responsible person (R.P.) of alarm and dispatch. At least three attempts over the course of one hour are made to notify the call list of alarms. If no contact can be reached, then the fire department is recalled to FOLLOW UP on the outcome of the dispatch. After follow-up, messages can be left on call list machines with complete information.

Possible Causes: Actual fire or sprinkler water flow. Possible false alarm due to cooking smoke, shower steam, dirt in the detectors, construction work going on, or alarm malfunction.

Suggested Operator Script:

NON-BOSTON DISPATCH: Good (morning / afternoon / evening), this is ____ alarm company calling. We have a fire alarm coming from (premises / address). The subscriber name there is ___. The signal is coming from (zone description). This is operator number ___, my call back number is 781-596-0000, and I will attempt to notify.

BOSTON DISPATCH: Good (morning / afternoon / evening), this is ____ alarm company and I am receiving a fire alarm from WYN###. This is operator number ___. My call back number is 781-596-0000, and I will attempt to notify.
After fire dispatch, a call is placed to the premises number to alert anyone answering to the fire alarm condition, and he or she is advised to wait outside for the fire department to arrive. If the person at premises has ID and states no actual fire exists, then the fire department is updated with this information.

**NOTIFY:** Good (morning / afternoon / evening), is (R.P. name) in please? This is ____ Alarm Company calling. We have you on the call list for (subscriber name). Their fire alarm at (subs address) has gone off and the fire department has been dispatched.

**FOLLOW UP:** Good (morning / afternoon / evening). This is ____ Alarm Company calling. We’re trying to do a follow up on an earlier dispatch to (subscriber’s address). We’ve been unable to reach anyone from the call list and we would like to make sure everything was OK. Thank you and have a good day.

**GAS (GAS):**

**Explanation:** This is a signal sent from the premises alerting us to the possibility of toxic or explosive gas present. (Usually carbon monoxide or natural gas) This information should come from the alarm company verified by the fire department at the time of installation.)

**Response Plan:** The Monitoring Center will call the premises, unless in a dispatch-immediately city or otherwise noted in account, and attempt to abort the alarm. If someone answers at the premises they will be notified of the type of alarm we are receiving and asked if they need assistance. An ID and name will be obtained, and the person will be asked if everyone at the premises is feeling all right. They will be asked if anyone is experiencing any headache, dizziness, or nausea. If they answer yes to any of these questions, then the fire department should be notified to investigate the source of the toxic gas even if proper ID is given. If premises number is busy, there is an answering machine, no answer, or no ID given, we will dispatch the fire department and notify the call list. If ID given and no adverse symptoms or signs of gas, then the person will be advised to have service check the gas detectors for malfunction.

**Procedure:** Hit Enter to retrieve the signal from the traffic screen and check comments and history (ALT-F3, ALT-F4, and ALT-F6) to be certain alarm is verifiable. (Some cities require dispatch immediately on all gas alarms.) Verify at premises by picking up a phone line and hitting F2 to autodial the premises, unless comments indicate otherwise. Get name and ID of person answering, notify of type of alarm received and ask if all at the premises are all right. Ask if anyone is experiencing headache, dizziness or nausea. If anyone is experiencing these symptoms, advise them the fire department will be sent to check and they should wait outside for them to arrive. If proper ID is given and sub says everyone at premises is fine and no reason for alarm, then advise them to have service check the detector. If no answer, no ID or improper ID is given, dispatch fire department and notify the call list.

**Possible Causes:** Actual toxic gas leak from a gas heater, gas dryer, generator, gas grill, propane tank, etc. Dirt or dust in detector, spray-painting or construction work going on without detector covered, or possible detector malfunction.

**Suggested Operator Script:**

**VERIFY:** Good (morning / afternoon / evening), this is ____ alarm company calling. We are receiving a gas alarm for (type of gas listed in zone). Is everyone all right? Does anyone feel dizzy, nauseous, or have a headache? Can I have your ID and your name? If everything is fine and there is no gas leak, then you may want to have your service department check this detector. If anyone feels ill or wrong ID given, then dispatch fire department.

**DISPATCH:** Good (morning / afternoon / evening), this is ____ alarm company calling. We are receiving a gas alarm for (type of gas listed in zone) from (premises address). The subscriber name there is ____. (Give any information gained from verification attempt.) This is operator number __. My call back number is 781-596-0000, and I will attempt to notify.

**NOTIFY:** Good (morning / afternoon / evening), this is ____ alarm company calling for (RP name). We have you listed on the call list for (subscriber name). Their (state type of gas listed in zone info) gas alarm has tripped and the fire department has been sent to check.
# Appendix 2

## Applicable UL Listings & procedures

<table>
<thead>
<tr>
<th>Toxic and explosive Gas detector</th>
<th>Gas UL Listings</th>
<th>Non System internal Battery &amp; 120AC interconnect Residential Detectors push button test</th>
<th>System connection / listing</th>
<th>UL Category</th>
<th>UL/FM Central Station or Municipal reporting</th>
<th>First Responder per Hazmat and EMT procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Residential</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>UL 2034</td>
<td><strong>CZHF</strong> Multiple &amp; Single Station Carbon Monoxide</td>
<td>NONE</td>
<td><strong>CZHF</strong></td>
<td>NONE</td>
<td>NONE</td>
</tr>
<tr>
<td>Propane Butane</td>
<td>UL 1481</td>
<td><strong>JKIS</strong> Residential &amp; recreational vehicle propane /gas</td>
<td>NONE</td>
<td><strong>JKIS</strong></td>
<td>NONE</td>
<td>NONE</td>
</tr>
<tr>
<td><strong>Commercial</strong></td>
<td></td>
<td>System connected and suitable for remote monitoring</td>
<td>Supervised with central supervised battery backup and wiring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Gas Toxic/Explosive</td>
<td>Gas UL Listing</td>
<td>System Detector description with testing per NFPA procedures for Smoke Detection utilizing a calibrated test gas suitable for the detector</td>
<td>System connection / listing</td>
<td>UL category</td>
<td>Automatic reporting procedure</td>
<td></td>
</tr>
<tr>
<td>Carbon Monoxide Test/calibrated gas</td>
<td>UL 2034</td>
<td>CO detector for supervised connection to a listed panel (UL 864 or 925) and central receiving station</td>
<td><strong>UL 2075</strong> <strong>FTAM</strong> Call, verify and dispatch, evacuate Contact ID Code # 162</td>
<td></td>
<td>EMT with breather pack and oxygen &amp; CO STAT</td>
<td></td>
</tr>
<tr>
<td>Propane/Butane/Methane Test/calibrated gas</td>
<td>UL 1481</td>
<td>Propane/Butane detector for supervised connection to a listed panel (UL 864 or 925) and central receiving station</td>
<td><strong>UL 2075</strong> <strong>FTAM</strong> Call, verify and evacuate Contact ID Code # 151</td>
<td></td>
<td>Gas Company with back up by Fire Dept Hazmat</td>
<td></td>
</tr>
</tbody>
</table>
8.7.5 Functional Test of Carbon Monoxide Detectors.

8.7.5.1 For all system detectors installed after January 1, 2012, carbon monoxide tests shall be performed at initial acceptance and annually by introduction of carbon monoxide into the sensing chamber or element. An electronic check magnets, analog values, etc.) is not sufficient to comply with this requirement.

8.7.5.2 The functional test shall be performed in accordance with the manufacturer's published instructions.

8.7.5.3* The result of each carbon monoxide detector test shall be confirmed through indication at the detector and the control unit.

8.73.4 All tests and results shall be recorded.

8.7.6 Sensitivity Testing. In other than one- and two-family dwellings, sensitivity of [carbon monoxide detectors I and single- and multiple-station [carbon monoxide] alarms shall be tested in accordance with 8.7.6 / through 8.7.6.4.5. [72:10.4.4.2]

8.7.6.1 This requirement shall become effective January 1, 2015.

8.7.6.2 Sensitivity shall be checked within 1 year after installation. [72:10.4.4.2.1]

8.7.6.3 Sensitivity shall be checked every alternate year thereafter unless otherwise permitted by compliance with 8.7.6.4. [72:10.4.4.2.2]

8.7.6.4 After the second required calibration test, if sensitivity tests indicate that the device has remained within its listed and marked sensitivity range, the length of time between calibration tests shall be permitted to be extended to a maximum of 5 years. [72:10.4.4.2.3]

8.7.6.4.1 If the frequency is extended, records of nuisance alarms and subsequent trends of these alarms shall be maintained. [72:10.4.4.2.3.1]

8.7.6.4.2 In zones or in areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed. [72:10.4.4.2.3.2]

8.7.6.4.3 To ensure that each [carbon monoxide detector] or [carbon monoxide] alarm is within its listed and marked sensitivity range, it shall be tested using a listed test method. Any of the following methods shall be performed:

1. Calibrated test method
2. Manufacturer's calibrated sensitivity test instrument
3. Listed control equipment arranged for the purpose
4. Control unit arrangement whereby the detector causes a signal at the control unit where its sensitivity is outside its listed sensitivity range
5. Other calibrated sensitivity test methods approved by the authority having jurisdiction [72:10.4.4.2.4]

8.7.6.4.4 Detectors or alarms found to have a sensitivity out of the listed and marked sensitivity range shall be cleaned and recalibrated or be replaced. [72:10.4.4.2.5]

Exception: Device listed as field adjustable shall be permitted to be either adjusted within the listed and marked sensitivity range and cleaned and recalibrated, or they shall be replaced. [72:10.4.4.2.5]

8.7.6.4.5 The detector or alarm sensitivity shall not be tested or measured using any device that administers an unmeasured

8.8 Maintenance.

8.8.1 [Carbon monoxide detection] system equipment shall be maintained in accordance with the manufacturer's published instructions. [72:10.5.1]

8.8.2 All apparatus that require resetting to maintain normal operation shall be restored to normal as promptly as possible after each test and alarm and kept in normal condition for operation. All test signal received shall be recorded to indicate date and time [. [72:10.5.4]

8.9 Records.

8.9.1 Permanent Records.

8.9.1.1 After successful completion of acceptance tests satisfactory to the authority having jurisdiction, a set of reproducible as-built installation drawings, operation and maintenance manuals, and a written sequence of operation shall be provided to the building owner or the owner's designated representative.

8.9.1.2 It shall be the responsibility of the owner to maintain these records for the life of the system and to keep them available for examination by any authority having jurisdiction.

8.9.1.3 Paper or electronic media shall be permitted.

8.9.2 Maintenance, Inspection, and Testing Records.

8.9.2.1 Records shall be retained until the next test and for one year thereafter. [72:10.6.2.1]

8.9.2.2 System shall be clearly identified by a placard, sticker, or similar means to indicate the next regularly scheduled inspection period in accordance with Figure 8.9.2.2.

Exception: If the device has been tested as part of the normal carbon monoxide alarm testing, the existing means of indicating the next regularly scheduled inspection period shall be permitted.

8.9.2.3 If off-premises monitoring is provided, records of signals, tests, and operations recorded at the monitoring center shall be maintained for not less than 12 months.

8.9.2.4 Upon request, a hard copy record shall be available for examination by the authority having jurisdiction.

8.9.2.5 Paper or electronic media shall be permitted.

8.10 Single- and Multiple-Station Carbon Monoxide Alarms.

8.10.1 Single- and multiple-station carbon monoxide alarms and all connected appliances shall be inspected and tested in accordance with the manufacturer's published instructions at least monthly.

8.10.2 Alarms shall be replaced when either the end-of-life signal is activated or the manufacturer's replacement date is reached. Alarms shall also be replaced when they fail to respond to operability tests.

8.10.3 Where batteries are used as a source of energy, they shall be replaced in accordance with the alarm equipment manufacturer's published instructions. [72:10.4.8]

8.11 Household Carbon Monoxide Detection Systems.


8.11.1.1 Household carbon monoxide detection systems shall
Appendix 3
ON SITE CO STAT for 1ST responders and Victims

SpCO® Carboxyhemoglobin

Carboxyhemoglobin (SpCO®) is a breakthrough measurement that allows clinicians to noninvasively and immediately detect elevated levels of carbon monoxide in the blood-facilitating earlier diagnosis and treatment for patients poisoned by carbon monoxide.

A Deadly Poison Revealed with SpCO

In emergency medical services, SpCO helps protect both victims and first responders from the dangers of CO poisoning.

> In emergency medical services, SpCO helps protect both victims and first responders from the dangers of CO poisoning.
CO poisoning is often misdiagnosed because its symptoms are similar to the flu, and moderate poisoning is possible with no symptoms at all.

Noninvasive carboxyhemoglobin assessment helps first responders and EMTs determine CO levels in the blood and determine medical procedures facilitating earlier detection and treatment of CO poisoning by immediate application of oxygen and directed transport to a Hyperbaric Chamber facility as required.

A study examined data from the Undersea Hyperbaric Medicine Society's CO poisoning surveillance system (supported by the Centers for Disease Control) and found that patients who were initially measured using Pulse CO-Oximetry had an almost one-hour reduction in time from the end of CO exposure to treatment.

An ON SITE CO STAT helps paramedics and emergency medical technicians to detect CO poisoning—enabling prompt treatment and removal of those exposed to deadly CO in homes, hotels, and places of work. An evaluation can be done on site to determine if local hospital treatment only with Oxygen inhalation or additional Hyperbaric Chamber treatment is required determined by Medical protocol.

The SpCO helps firefighters reduce the risk of CO poisoning. Just one severe CO poisoning nearly doubles the risk of premature death, and consistent CO exposure may cause long-term heart and brain damage. Even mild levels of CO circulating in the blood, the heart and brain rob the body of critical oxygen which causes mental confusion that leads to poor decision making and increases the risk of heart disease or stroke—two conditions already accounting for nearly 50% of on-duty firefighter deaths.

Industry-leading organizations have lined up to support CO education, and the National Fire Protection Association (NFPA) introduced a new fire rehabilitation standard—NFPA 1584—that supports on-scene CO assessment of firefighters.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Type</th>
<th>CO Level in Air</th>
<th>Alarm Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACGIH — American Conference of Governmental Industrial Hygienists</td>
<td>TWA (8 Hours)</td>
<td>25 ppm</td>
<td>Smallest CO ppm amount for Low Alarm Level Trip/Setpoint</td>
</tr>
<tr>
<td>IMC — International Mechanical Code</td>
<td>TWA (1 Hour)</td>
<td>25 ppm</td>
<td>Acceptable CO ppm amount for Low Alarm Level Trip/Setpoint</td>
</tr>
<tr>
<td>NIOSH — National Institute for Occupational Safety and Health</td>
<td>TWA (1 Hour)</td>
<td>35 ppm</td>
<td>Acceptable CO ppm amount for Low Alarm Level Trip/Setpoint</td>
</tr>
<tr>
<td>EPA — Environmental Protection Agency</td>
<td>TWA (1 Hour)</td>
<td>35 ppm</td>
<td>Acceptable CO ppm amount for Low Alarm Level Trip/Setpoint</td>
</tr>
<tr>
<td>OSHA — Occupational Safety and Health Administration</td>
<td>OSHA PEL as TWA (8 Hours)</td>
<td>50 ppm</td>
<td>Acceptable CO ppm amount for Low Alarm Level Trip/Setpoint. Maximum concentration for low alarm!</td>
</tr>
<tr>
<td>UL - Underwriters Laboratories</td>
<td>UL 2034</td>
<td>70 ppm 15.4 HRS 400 ppm 15 min</td>
<td>CO ppm amount for Medium Alarm Level</td>
</tr>
<tr>
<td>Recommended set point Fan &amp; Alarm 50 ppm Fan ventilation per IBC 100/15M or 200 ppm /10 min per NIOSH</td>
<td>OSHA-IBC NIOSH</td>
<td>50 Ventilate 100-200 alarm</td>
<td>CO ppm amount for Ventilation High Alarm Level Trip/Setpoints</td>
</tr>
<tr>
<td>ACGIH — American Conference of Governmental Industrial Hygienists</td>
<td>Excursion Limit (EL)</td>
<td>125 ppm</td>
<td>Acceptable CO ppm amount for High Alarm Level Trip/Setpoint</td>
</tr>
<tr>
<td>NIOSH — National Institute for Occupational Safety and Health</td>
<td>Ceiling</td>
<td>200 ppm</td>
<td>Acceptable CO ppm amount for High Alarm Level Trip/Setpoint. Maximum concentration for high alarm!</td>
</tr>
</tbody>
</table>