What is carbon monoxide (CO) and why do I need a carbon monoxide detector?

Carbon monoxide is a colorless, odorless, tasteless and toxic gas produced as a by-product of combustion. Any fuel burning appliance, vehicle, tool or other device has the potential to produce dangerous levels of carbon monoxide gas. Examples of carbon monoxide producing devices commonly in use around the home include:

- Fuel fired furnaces (non-electric)
- Gas water heaters
- Fireplaces and woodstoves
- Gas stoves
- Gas dryers
- Charcoal grills
- Lawnmowers, snowblowers and other yard equipment
- Automobiles

The Consumer Products Safety Commission (CPSC) reports that approximately 200 people per year are killed by accidental CO poisoning with an additional 5000 people injured. These deaths and injuries are typically caused by improperly used or malfunctioning equipment aggravated by improvements in building construction which limit the amount of fresh air flowing in to homes and other structures.

While regular maintenance and inspection of gas burning equipment in the home can minimize the potential for exposure to CO gas, the possibility for some type of sudden failure resulting in a potentially life threatening build up of gas always exists.

What are the medical effects of carbon monoxide and how do I recognize them?

Carbon monoxide inhibits the blood's ability to carry oxygen to body tissues including vital organs such as the heart and brain. When CO is inhaled, it combines with the oxygen carrying hemoglobin of the blood to form carboxyhemoglobin. Once combined with the hemoglobin, that hemoglobin is no longer available for transporting oxygen. How quickly the carboxyhemoglobin builds up is a factor of the concentration of the gas being inhaled (measured in parts per million

or PPM) and the duration of the exposure. Compounding the effects of the exposure is the long half-life of carboxyhemoglobin in the blood. Half-life is a measure of how quickly levels return to normal. The half-life of carboxyhemoglobin is approximately 5 hours. This means that for a given exposure level, it will take about 5 hours for the level of carboxyhemoglobin in the blood to drop to half its current level after the exposure is terminated.

The following table describes the symptoms associated with a given concentration of COHb:

% COHb ***Symptoms and Medical Consequences*** 10% No symptoms. Heavy smokers can have as much as 9% COHb. 15% Mild headache. 25% Nausea and serious headache. Fairly quick recovery after treatment with oxygen and/or fresh air. 30% Symptoms intensify. Potential for long term effects especially in the case of infants, children, the elderly, victims of heart disease and pregnant women. 45% Unconsciousness. 50%+ Death.

Since one can't easily measure COHb levels outside of a medical environment, CO toxicity levels are usually expressed in airborne concentration levels (PPM) and duration of exposure. Expressed in this way, symptoms of exposure can be stated as follows:

PPM CO ***Time*** ***Symptoms*** 35 PPM 8 hours Maximum exposure allowed by OSHA in the workplace over an eight hour period. 200 PPM 2-3 hours Mild headache, fatigue, nausea and dizziness. 400 PPM 1-2 hours Serious headache- other symptoms intensify. Life threatening after 3 hours. 800 PPM 45 minutes Dizziness, nausea and convulsions. Unconscious within 2 hours. Death within 2-3 hours. 1600 PPM 20 minutes Headache, dizziness and nausea. Death within 1 hour. 3200 PPM 5-10 minutes Headache, dizziness and nausea. Death within 1 hour. 6400 PPM 1-2 minutes Headache, dizziness and nausea. Death within 25-30 minutes. 12,800 PPM 1-3 minutes Death.

As can be seen from the above information, the symptoms vary widely based on exposure level, duration and the general health and age on an individual. Also note the one recurrent

theme that is most significant in the recognition of carbon monoxide poisoning- headache, dizziness and nausea. These 'flu like' symptoms are often mistaken for a real case of the flu and can result in delayed or misdiagnosed treatment. When experienced in conjunction with a the sounding of a carbon monoxide these symptoms are the best indicator that a potentially serious buildup of carbon monoxide exists. This comment will be returned to later.

What are the different types of carbon monoxide detectors and how do they work?

There are a number of different types and brands of carbon monoxide detectors on the market today; They can be most easily characterized by whether they operate on household current or batteries. Underlying this, in most cases, is the type of sensor employed in the detectors operation. Detectors using household current typically employ some type of solid-state sensor which purges itself and resamples for CO on a periodic basis. This cycling of the sensor is the source of its increased power demands. Detectors powered by batteries typically use a passive sensor technology which reacts to the prolonged exposure to carbon monoxide gas.

Are some types of detectors better than others? How do I select the best detector for me?

Regardless of the type of sensor used all detectors sold on the market today should conform to minimum sensitivity and alarm characteristics. These characteristics have been defined and are verified by Underwriters Laboratory in their standard for carbon monoxide detectors UL 2034. This standard was most recently revised in June of 1995 and went into effect in October of 1995. This revision specified additional requirements regarding identification of detector type, low-level (nuisance) alarm sensitivity and alarm silencing. Under no circumstances should one purchase a detector that is not UL listed.

Each of the two types of detectors mentioned previously has applications in the home along with associated advantages and disadvantages. The proper detector for each application or installation should be chosen based on the application requirements and the products specifications. The following are the principle advantages and disadvantages of the two different type detectors:

Characteristic	***Household Current***	***Battery Operated***
Cost	$30-50	$30-50
Ease of Installation	More difficult- requires outlet near detector or 'hard wiring'.	Less difficult. Can be placed anywhere needed.
Maintenance	No maintenance required during life of product (5-10 years).	Requires periodic replacement of battery/sensor module every 2-3 years at a cost of ~$20.
Reaction Time/Exposure Level Display	Gives continuous display of CO levels updated every few minutes.	Reaction time depends on concentration level and duration of exposure. Display information is limited.
Reset Time	Will reset immediately once CO problem is corrected.	Reset time depends on exposure concentration and duration. May require removal of sensor pack. A silence button, however, is now provided/required.

How many carbon monoxide detectors should I have and where should I place them?

The Consumer Product Safety Commission recommends a detector on each floor of a residence. At a minimum, a single detector should be placed on each sleeping floor with an additional detector in the area of any major gas burning appliances such as a furnace or water heater. Installation in these areas ensures rapid detection of any potentially malfunctioning appliances and the ability to hear the alarm from all sleeping areas. In general, carbon monoxide detectors should be placed high (near the ceiling) for most effective use. Detectors should also not be placed within five feet of gas fueled appliances or near cooking or bathing areas. Consult the manufacturers installation instructions for proper placement of a detector within a given area.

What are the most common causes of carbon monoxide detector alarms?

There are many conditions which can cause a carbon monoxide detector to alarm. Most are preventable and few are actually life threatening. Ideally through proper placement of the detector and education of the users the number of preventable calls can be minimized and activation will only occur in the more serious situations.

Preventable causes of CO alarm activation and the recommended preventive action are as follows:

Cause	***Preventive Action***
Inadequate fresh air venting of the home.	Have a heating contractor install a fresh air makeup system in the home
Running gas powered equipment or automobiles in a home or garage	Gas powered equipment or vehicles should never be operated within a home or garage- even if the garage door is open. Since most homes are typically at a lower pressure relative to outside air, the gas can actually be drawn into the home.
Charcoal grilling in the home or garage.	Charcoal grilling is a tremendous producer of carbon monoxide gas. Charcoal grills should never be operated in the home.
Malfunctioning appliances or equipment in the home.	All fuel burning appliances or equipment in the home needs periodic inspection and preventive maintenance. While all fuel burning appliances will produce some CO gas, regular preventive maintenance can keep this to a minimum.
Malfunctioning or overly sensitive alarm.	Buy only UL Listed alarms conforming to the latest revision (June 1995) of UL standard 2034. This revision includes new requirements to minimize nuisance alarms.

While many causes can be prevented others can not and may occur unpredictably. Not only are these problems harder to predict but they also tend to be more serious in nature. Examples of these type problems are:

- Cracked furnace heat exchanger.
- Malfunctioning furnace or water heater.
- Blocked chimney.
- Other unpredictable events- vehicle left running in garage, gas powered device placed near fresh air vent to home, etc.

Minimizing preventable events allows everyone to take other less preventable and predictable events more seriously.

What should I do when my carbon monoxide detector goes off?

First and foremost, stay calm. As mentioned previously most situations resulting in activation of a carbon monoxide detector are not life threatening and do not require calling 911. To determine the need to call 911, ask the following question of everyone in the household:

"Does anyone feel ill? Is anyone experiencing the 'flu-like' symptoms of headache, nausea or dizziness?"

If the answer to the above by anyone in the household is true, evacuate the household to a safe location and have someone call 911. Failure to evacuate immediately may result in prolonged exposure and worsening effects from possible carbon monoxide gas. The best initial treatment for carbon monoxide gas exposure is fresh air.

If the answer to the above by everyone in the household is no, the likelihood of a serious exposure is greatly diminished and one probably does not need to call 911. Instead, turn off any gas burning appliances or equipment, ventilate the area and attempt to reset the alarm. If the alarm will not reset or resounds, call a qualified heating and ventilating service contractor to inspect your system for possible problems. If at any time during this process someone begins to feel ill with the symptoms described above evacuate the household to a safe location and have someone call 911.

What can I expect to happen if I call 911?

What to expect when calling 911 is based on the polices and procedures of the public safety agencies serving your community and will vary from area to area. Most public safety agencies are, however, recognizing the dangers posed by carbon monoxide gas and are adopting similar procedures to the ones described below. These procedures are based on information developed by the International Association of Fire Chiefs (IAFC) and other national and regional associations. The objective of these procedures is to quickly determine the severity of the situation and provide the proper emergency response. The following is a summary of what one can expect to happen if the call 911 because a carbon monoxide detector is sounding:

When initially calling 911 be prepared to provide the following information:

- Your address.
- The type of detector that is sounding.
- Whether or not anyone is feeling ill with 'flu-like' symptoms as previously described.
- Whether or not everyone has evacuated the residence.
- The reading on the detector (if known or available)

The dispatcher will determine the response required based on the answers to the above- most significantly whether or not anyone is feeling ill.

If anyone is feeling ill and/or you can not or have not been able to evacuate everyone, law enforcement, medical and fire personnel will be assigned to the call on an emergency basis. Law enforcement to assist with the immediate evacuation of individuals, medical to treat any victims and fire to monitor for CO gas and assist with the other activities.

If no one is feeling ill, you may be advised to contact your local heating contractor or gas company to assist you or, more likely, fire personnel will be dispatched on a routine basis to monitor for CO gas and advise if a 'real' carbon monoxide problem exists.

As mentioned previously, response policies vary by community and you may wish to call your local fire or police non-emergency number to ask what their particular policies are. An example standard operating procedure for CO alarms
is attached. This policy is based on the IAFC model procedures and has been adopted by the Hennepin County Fire Chiefs Association as their 'standard' policy for fire departments which are part of that association.

Where can I get further information concerning carbon monoxide detectors?

Several manufacturers of carbon monoxide detectors offer toll free numbers for additional information regarding their products. These numbers are as follows:

Manufacturer	***Number***
American Sensors	800-387-4219
Enzone	800-448-0535
First Alert	800-323-9005
Jameson	800-779-1719
Nighthawk	800-880-6788
Quantum	800-432-5599
Radio Shack	Contact your local store
S-Tech	800-643-5377

Additional information with product ratings is contained in the July 1995 Consumer Reports issue on home safety products. One word of note regarding the ratings in this issue- the products tested have probably since be replaced by updated models conforming to the revised UL 2034 standard which took effect in October 1995. Check with the manufacturer for current information.

This information provided as a public service by the Hamel Volunteer Fire Department.
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