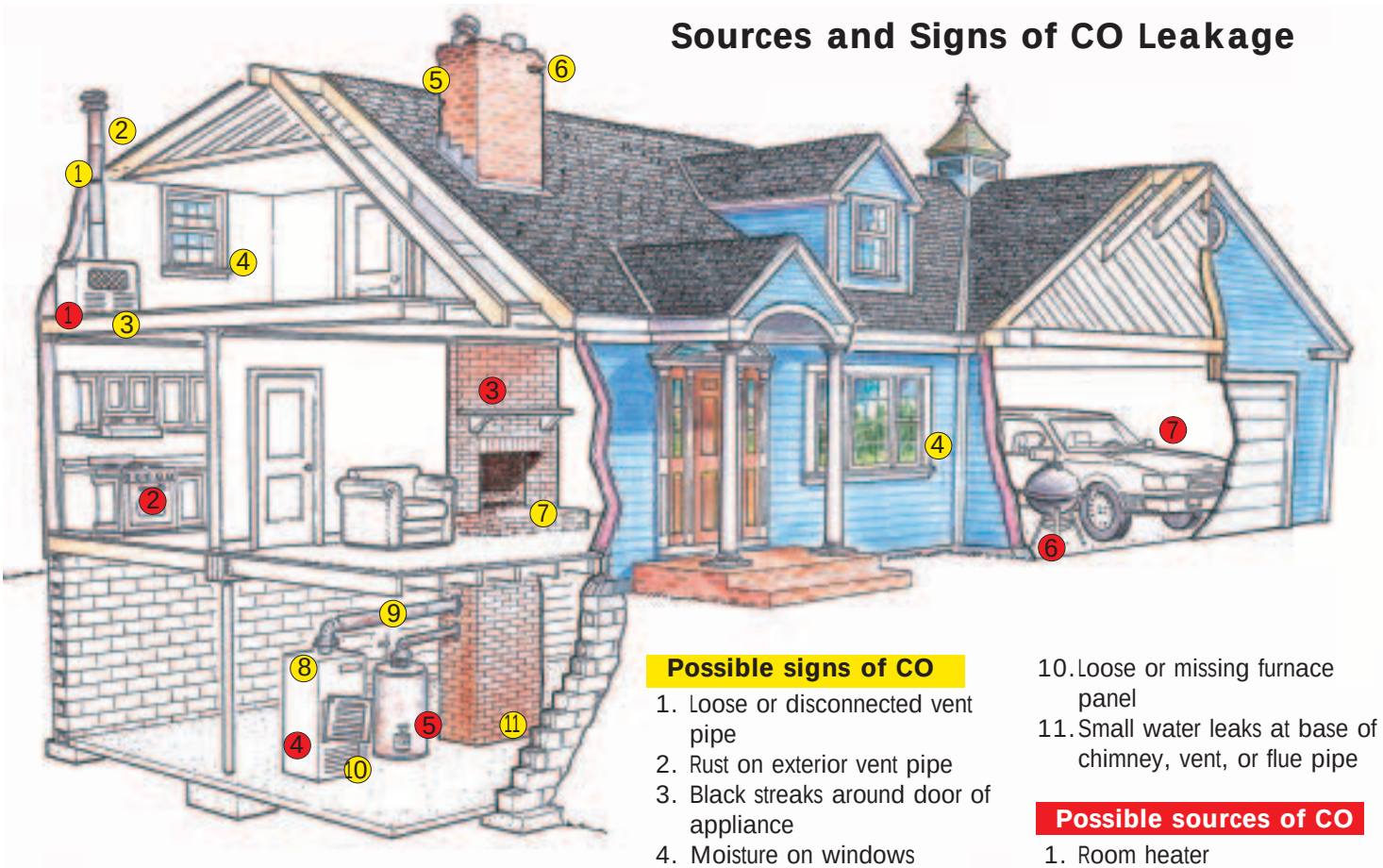
Carbon Monoxide Detectors

A trend in state and municipal regulations will soon make CO detectors a standard installation in residential projects



Most CO leaks leave telltale signs at the source or on nearby finish materials. However, some CO problems are hidden — such as chimney damage or a cracked combustion chamber — and can be discovered only through regular inspections.

Possible signs of CO

1. Loose or disconnected vent pipe
2. Rust on exterior vent pipe
3. Black streaks around door of appliance
4. Moisture on windows
5. Poor chimney draft
6. Damaged or discolored bricks at chimney top
7. Fallen soot in fireplace
8. Moisture on furnace walls
9. Excessive rust on flue pipe or appliance jacket
10. Loose or missing furnace panel
11. Small water leaks at base of chimney, vent, or flue pipe

Possible sources of CO

1. Room heater
2. Range
3. Fireplace
4. Furnace
5. Water heater
6. Charcoal grill
7. Auto in closed garage

Every year, carbon monoxide (CO) kills 200 to 300 Americans and poisons more than 5,000 others. This poisonous gas — which can't be seen, tasted, or smelled — can originate from a wide variety of sources, including a car or lawn mower left running in an attached garage, improper venting of a kitchen range, or a cracked or disconnected vent pipe for a combustion appliance (see illustration above).

As construction technology has advanced, the danger of carbon monoxide poisoning has actually increased. Chimneys in tighter, energy-efficient houses are more likely to backdraft, and high-efficiency heating units now produce cooler flue gases that are less likely to vent naturally. Consumer awareness is heightened, too, driven in part by homeowners' increasing concern for indoor air quality, and by agencies like the U.S. Consumer Product Safety Commission (CPSC), which now urges all homeowners with fuel-burning appliances or attached garages to install UL-listed (Underwriters Laboratories) CO detectors.

While code bodies are feeling the pressure to require CO detectors in one- and two-family dwellings, to date no regional building codes (like BOCA and ICBO) require CO detectors. Increasingly, however, state and city codes do: Currently, 16 cities in New York, New Jersey, Ohio, Illinois, Missouri, and Texas have ordinances requiring CO detectors. Specifics vary from requiring CO detectors in all new homes or upon

by John D. Wagner

AIM SAFETY HOME PRODUCT CO.

Figure 1. *Although most electrochemical CO detectors are too expensive for residential use, AIM makes an affordable ($70) battery-operated model. After five years, the unit is discarded, together with the sealed battery inside, and replaced.*

Nuisance Alarms

In 1994, a freak atmospheric shift, called a thermal inversion, brought carbon monoxide from high in the atmosphere to ground level in Chicago. More than 1,000 CO detectors throughout the city simultaneously sounded an 85-db alarm. Conscientious homeowners followed the manufacturers instructions and called the fire department. The volume of calls highlighted the problem of carbon monoxide nuisance alarms for everyone involved. A subsequent American Gas Association (AGA) study estimates that 90% of all carbon monoxide calls to fire departments and utilities are false alarms — either no CO is found or the CO level is within the acceptable range.

Reset procedure. To address this problem, UL made several changes to its UL 2034 listing in 1995. The first change simply reworked the instructions in the manufacturers' literature on what to do if the CO detector sounds an alarm. Instead of immediately calling the fire department, users are now told to do a head count, evacuate and ventilate the building, and check for symptoms of CO poisoning.

The second change UL made in 1995 was to require reset buttons on CO detectors. Most CO detectors before UL's 1995 update didn't have reset buttons, so there was no way to double-check for CO presence without calling the fire department. Now when a detector sounds an alarm, users who have first followed the evacuation procedures and who have not found any symptoms of CO poisoning can double-check by resetting the detector. During the reset period, the detector continues to check for CO, but its alarm is muted. If after a maximum of six minutes (most detectors cut this to under three minutes) the detector senses a continued presence of CO — as opposed to a one-time blast of CO that has harmlessly dissipated — the detector sends out a second alarm, signaling a CO problem.

Response time. To cut down on nuisance alarms, the 1995 UL standard also changed the response time of the detector. Before 1995, the detectors sent out an alarm anytime CO levels reached 15 ppm for 8 hours. After the 1995 change, the "nuisance level" of CO — the level at which an alarm must *not* sound — was lowered to 15 ppm for 30 days. — *J.W.*

sale of homes, to including detectors as part of remodeling work. This is a trend we are sure to see more of. The CPSC is also poised to renew its once-active lobbying efforts to include CO detectors in the codes.

Sensor Technology

In the absence of code requirements, code organizations refer contractors to UL-listed products (see "Sources of Supply"). UL first listed CO detectors in 1992, under the UL 2034 standard. But a rash of false alarms in Chicago caused UL to revise this standard in 1995 (see "Nuisance Alarms," at left). However, UL didn't issue a new standard number with the 1995 changes, so individual manufacturers must identify compliance on their own. Some companies simply mark their products "UL 2034-95" to indicate compliance with the 1995 standard; others carry an American Gas Association (AGA) certification. (The AGA doesn't have its own standard, but it tests to the UL standard.)

CO detectors work by sensing density of carbon monoxide in the air. There are four types of sensors: infrared and electrochemical, which are common in industrial or specialty applications; and semiconductor and enzyme sensors, typically used in households. (A fifth type of sensor, sometimes called "badge technology," uses a chemically treated patch that changes color when CO is present. While no batteries are required, there is no alarm, either — users must visually inspect the badge for a change in color before realizing CO is present.)

Infrared detectors are very accurate, but are too expensive — around $300 each — for most residential applications.

Electrochemical sensors are extremely sensitive, and have a digital display. The portable models are very popular with fire departments. However, besides being too expensive (from $600 to $2,000) for household applications, the sensitivity changes as the sensors age, requiring recalibration every six months.

One company does make an electrochemical sensor suitable for residential use, but without a digital readout. AIM Safety's SAS CO detector (Figure 1) is self-calibrating, costs around $70, and is sealed with its battery. Users discard the unit after about five years of use.

Semiconductor sensors make up 90% of residential units on the market today, and most UL-listed CO detectors are semiconductor types. The semiconductor samples the air about every two and a half minutes, records the information, and samples again after burning off impurities. If the CO level reaches the "must alarm" threshold of 100 parts per million (ppm) and remains there for 90 minutes, the alarm sounds.

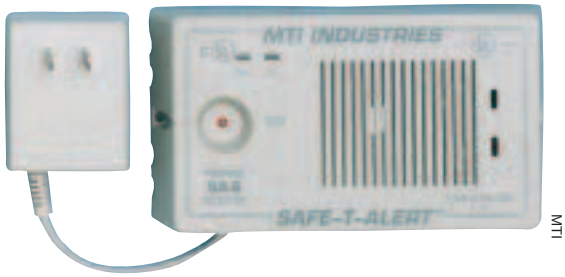
The alarm is triggered sooner with higher CO levels or with a rapid rise in CO concentration. For example, UL 2034-95 specifies that the alarm must sound no longer than 35 minutes after CO levels

reach 200 ppm, no longer than 15 minutes at 400 ppm, and so on. In general, the higher the concentration, the faster the alarm response time. (There is a "high grade" and "low grade" of semiconductor sensor. High-grade semiconductors have fewer nuisance alarms.)

Semiconductor detectors should be hard-wired to 110/120-volt circuits. Backup batteries offer only four hours of coverage because of the energy required to heat up the semiconductor.

MTI offers four semiconductor units, all of which comply with UL 2034-95 and cost about $40: a "direct plug-in" model for use with a standard receptacle; a "line cord" unit that comes with a plug-in transformer and 6 feet of low-voltage cable (Figure 2); a second line cord model that can be mounted remotely (for example, the transformer in the basement and the detector on the second floor, with wires running between them in the wall); and a hard-wired line-voltage detector that mounts in its own box.

Nighthawk offers three semiconductor units that comply with UL 2034-95, all of which can be mounted in one of three ways: directly plugged into a receptacle, plugged in with an integral extension cord, or hard-wired to a gang box. Model 900-0032 ($25) uses a simple audio alarm; Model 900-0014 ($40) displays CO levels digitally; and Model 900-0046 ($60) features a digital display, with a memory that records the highest CO level in the last 24 hours (so you can check if CO levels are rising or falling). BRK Electronics' two-stage model CO2120P ($50) is also designed for direct plug-in.



MTI


BRK ELECTRONICS

Figure 2. *MTI's Safe-T-Alert series (above) of semiconductor-type CO detectors can be directly plugged into a receptacle, hard-wired in a gang box, or powered by an integral or remote transformer. BRK Electronics' CO2120P plug-in detector (right) has a two-stage 85-db alarm as well as a yellow warning light and a red full-alarm light.*

Enzyme sensors are the least expensive CO detectors. A chemical gel in the sensor is actually a synthetic hemoglobin that absorbs CO at the same rate as real blood. An LED senses light passing through the gel. If the gel is clear no alarm sounds,

Symptoms of CO Poisoning

Carbon monoxide is a colorless, tasteless, odorless gas produced by the incomplete combustion of natural gas, propane, coal, oil, charcoal, or wood. When inhaled, carbon monoxide enters the bloodstream and replaces oxygen molecules in hemoglobin, depriving the heart and brain of oxygen. As carbon monoxide blood levels increase, the heart works faster to distribute oxygen-deprived blood throughout the body, raising the victim's blood pressure and pulse, and often giving the victim a pinkish "flushed" appearance. Eventually, carbon monoxide will cause breathing difficulty, heart damage, brain damage, coma, and eventual death. Early symptoms are often mistaken for a bad cold or the flu (without the fever).

PPM (parts per million)	EXPOSURE TIME	SYMPTOMS
35 ppm	8 hours	Maximum 8-hour exposure allowed by OSHA in the workplace.
200 ppm	2-3 hours	Mild headache; fatigue, nausea, dizziness, slight headache.
400 ppm	1-2 hours	Serious headache, other symptoms intensify; life threatening after 3 hours.
800 ppm	45 minutes	Dizziness, nausea, convulsions; unconscious within 2 hours; death within 2-3 hours.
1,600 ppm	20 minutes	Headache, dizziness, nausea; death within 1 hour.
3,200 ppm	5-10 minutes	Headache, dizziness, nausea; death within 1 hour.
6,400 ppm	1-2 minutes	Headache, dizziness, nausea; death within 1 hour.
12,800 ppm	1-3 minutes	Death.

but if the gel clouds up — as it does in the presence of CO — the sensor sounds an alarm. The advantage of enzyme sensors is that they can run on batteries (especially appropriate for RVs, boats, camps, and remote locations). The disadvantages are that the batteries must be maintained and, more important, the gel can be darkened by humidity, wood smoke, soot, and grease, causing false alarms. If the gel becomes clouded by something other than CO, the detector can go into constant alarm, often prompting users to unplug the battery. However, the sensor pack can be replaced for about $25 if the gel gets clouded.

Quantum's line of battery-operated enzyme detectors, called "bio-mimetic" sensors, are UL listed and cost between $40 and $90 (Figure 3). BRK Brands, makers of the popular First Alert battery-operated consumer products, also makes a line of contractor-grade detectors under the name BRK Electronics. The model CO1120B ($50) combines hard wiring with battery backup and can be interconnected with smoke detectors.

Figure 3. *Enzyme detectors sense the amount of light passing through a synthetic hemoglobin gel. Cloudy gel signals the presence of absorbed CO and sets off the alarm. Quantum makes a battery-operated model (left); BRK Electronics' hard-wired model CO1120B (right) is equipped with battery backup and can be interconnected with a series of smoke detectors*

Location and Wiring

If you install only one CO detector, locate it near the bedrooms, because most CO deaths occur while the victims are asleep. For complete coverage, UL suggests three detectors: one at the top of the second-story stairway, one in the kitchen, and one at the top of the basement stairway.

Hard-wired units are made up with wire nuts, just like a receptacle, and the detector chassis is screwed into a wall- or ceiling-mounted bracket supplied by the manufacturer. Direct plug-ins fit any standard receptacle, but should be installed out of the reach of children. Not only may the detector tempt children to remove it, exposing them to the danger of electrical shock, but children who repeatedly set the alarm off by pressing the test button may prompt their harried parents to unplug the device, defeating its purpose.

Line cord units are typically wall mounted, with a two-wire low-voltage cord (like a thermostat cable) running to a 24-volt transformer, either plugged into an outlet or mounted at a remote location. Models with integral extension cords can be wall mounted at eye level with the cord plugged into a nearby receptacle.

Protecting Workers

Unvented or improperly vented natural gas or LP heaters commonly used on job sites in cold weather are possible sources of deadly carbon monoxide gas. Gas-operated pumps and generators pose a similar hazard. In poly-tented work areas, there may be enough fresh air supplied through leakage to defeat CO dangers, but in structures shelled in and sealed against the weather, carbon monoxide poisoning of workers is a real hazard that shouldn't be ignored.

A $40 plug-in CO detector can provide low-cost peace of mind. Locate the CO detector at the top of a stairway, or plug it in near the fuel-burning appliance. Use a plug-in with a semiconductor rather than a battery-operated enzyme sensor, which can easily be made useless by sawdust or drywall dust. Also, dead detector batteries can easily go undetected on site, and workers may be tempted to "borrow" the detector's batteries for radios or flashlights. ■

Contributing editor John D. Wagner writes frequently on construction-related topics from his home in Montpelier, Vt.

Sources of Supply

AIM Safety Home Product Co.
8403 Cross Park Dr., Suite 1-C
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800/275-4246

American Sensor
575 Bond St.
Lincolnshire, IL 60069
800/387-4219

BRK Brands
3901 Liberty Street Rd.
Aurora, IL 60504
800/323-9005

Enzone U.S.A.
P.O. Box 290480
Davie, FL 33329
800/448-0535

Jameson Home Products, Inc.
2820 Thatcher Rd.
Downers Grove, IL 60515
800/779-1719

MTI
Don Smith and Associates, Inc.
P.O. Box 493700
Redding, CA 96049
800/221-4785

Nighthawk System, Inc.
4980 Centennial Blvd.
Colorado Springs, CO 80919
800/880-6788

Quantum Group Inc.
11211 Sorrento Valley Rd.
San Diego, CA 92121
800/432-5599