

CARBON MONOXIDE

Background Materials

CEHRC's Carbon Monoxide Background Materials give an introduction to the hazards posed by carbon monoxide in housing. These materials are intended to assist community-based organizations conducting indoor environmental sampling campaigns in understanding the issues around carbon monoxide poisoning, and accompany CEHRC training in carbon monoxide assessment. The Background Materials may also be of interest to the general public concerned about indoor environmental health issues.

1. **Why Is Carbon Monoxide a Health Hazard?**
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3. **How to Test for Carbon Monoxide Using this Protocol**
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Why Is Carbon Monoxide a Health Hazard?

Fuel such as wood, gasoline, natural gas, propane, kerosene, coal and fuel oil provide us with energy that allows our society to function. In our homes, we depend on these fuels for warmth and cooking. When these fuels are burned, they generate carbon dioxide and water. Depending on the fuel and the way it is burned, toxic pollutants such as carbon monoxide, sulfur dioxide, nitrogen oxides, and volatile organic compounds may also be generated.

Carbon monoxide (CO) directly affects the body by reducing the amount of oxygen that your red blood cells can carry. It can starve the body of oxygen. Carbon monoxide is especially dangerous because you do not know when you are being poisoned. You cannot see, smell, or taste carbon monoxide.

Exposure to low levels of carbon monoxide may be confused with a cold or the flu due to symptoms of headaches, dizziness, or nausea. You may also simply feel tired and stop thinking clearly. Occasionally you may experience headache or fatigue. Carbon monoxide poisoning is often misdiagnosed by both victims and doctors.

Dangerous amounts of carbon monoxide can be released when there is not enough fresh air or a flame is not hot enough to completely burn a fuel (i.e., the flame is yellow). For example, the smoldering burn of incense or cigarettes produces carbon monoxide. So do:

- Cars, especially when the engine is being warmed up;

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- Gas stoves with a flame that burns yellow;
- Furnaces with a cracked heat exchanger or leaking chimney that leaks gases into the ventilation system;
- Fireplaces;
- House fires; and
- Gas or propane space heater used indoors without proper ventilation.

The higher the carbon monoxide level and the longer the exposure, the more damage done. Getting the person who has been exposed to carbon monoxide to fresh air always helps but damage to the brain, central nervous system, and heart can be permanent. Infants, children, pregnant women, the elderly, and people with heart or respiratory problems are most susceptible to carbon monoxide poisoning.

The damage done by carbon monoxide depends on:

- How much carbon monoxide is in the air;
- How long the person was exposed;
- The person's size; and
- Whether the person was exercising.

Understanding the Effects of CO Exposure Based on healthy adults (children, pregnant women & elderly as well others at higher risk may be affected at even lower levels) (This table adapted from information provided in the Nighthawk instructions pamphlet.)	
Concentration of CO in Air (ppm = parts per million)	Approximate Inhalation Time and Symptoms Developed
200 ppm	Slight headache, fatigue, dizziness, nausea after 2-3 hours
400 ppm	Frontal headaches within 1-2 hours, life threatening after 3 hours
800 ppm	Dizziness, nausea & convulsions within 45 minutes; unconsciousness within 2 hours; Death within 2-3 hours
1,600 ppm	Headache, nausea, dizziness within 20 minutes; Death within 1 hour
3,200 ppm	Headache, nausea, dizziness within 5-10 minutes; Death within 25-30 minutes
6,400 ppm	Headache, nausea, dizziness within 1-2 minutes; Death within 10-15 minutes
12,800 ppm	Death within 1-3 minutes

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Carbon monoxide can – and does – kill. The Consumer Product Safety Commission (CPSC) estimates that more than 500 people a year are accidentally killed by carbon monoxide in the United States. Motor vehicle exhaust is the leading cause of death. Gas appliances in the home are next.

On average, more than 200 people per year die from accidental carbon monoxide poisonings from consumer products *not* related to engine exhaust or fires. 68% of these deaths occur in the home, and an additional 14% in temporary shelters.

Even if it doesn't kill, carbon monoxide can cause serious health problems. From 1995 to 1999, more than 10,000 people per year went to the emergency room with carbon monoxide poisoning. 3% of these patients were hospitalized.

Estimated Non-Fire, Non-Auto Carbon Monoxide Poisonings by Type of Consumer Product Reported			
Consumer Product		Average Percent (1993-1997) (207 Avg. Deaths)	Average Percent (1995-1999) (10,200 Avg. Injuries)
Heating System	Gas	39%	22%
	Coal/Wood	3%	4%
	Kerosene/Oil	5%	4%
	Other or Unknown	19%	26%
	Total Heating	66%	56%
Charcoal Grills		20%	6%
Gas Ranges/Ovens		8%	
Gas Water Heaters		8%	4
Camp Stoves, Lanterns		9%	
Other or Unknown Appliances		5%	30%

Why Test for Carbon Monoxide Hazards?

Because of the use of old appliances or poor ventilation, many homes in the US have high levels of carbon monoxide. A few homes have extremely high levels that can kill.

You must use an alarm to determine whether carbon monoxide is a problem in a home because you cannot see, smell or taste it.

How to Test for Carbon Monoxide

The only reliable method to test for carbon monoxide is with an electronic device called a carbon monoxide alarm. Fire departments, gas companies and some specialized contractors have sophisticated equipment that can measure and record carbon monoxide levels.

The Hazard Investigator will use the alarm in two ways:

1. Check the home during a visit when the appliances are in use to determine if there might be a problem and what the source might be;
2. Leave the alarm in the home for one week to several months to record the highest levels that may be present.

Supplies:

The following supplies and equipment are used to test for carbon monoxide.

Carbon Monoxide Alarm that:

- Meets the Underwriters Laboratory® Standard for residential carbon monoxide alarms – look for the UL in a circle logo on the container.
- Is able to operate on home electricity, and a battery, even temporarily.
- Has a digital display of the measured carbon monoxide level.
- Stores and recalls the highest level of carbon monoxide detected.

Alarm instructions. Make extra copies so you can keep them in your files and leave a copy with the resident.

Incense and a lighter or matches. You will need to regularly test the alarm by lighting incense and allowing the smoke to enter the alarm.

Spare battery. Most alarms use a 9-volt battery.

Carbon Monoxide Report

Floor Plan

Sampling Results Report

About the Alarm:

CEHRC uses high-end consumer carbon monoxide alarm. While called an alarm, these high-end consumer alarms also monitor and record carbon monoxide levels. A typical alarm only sounds when there are life-threatening levels of carbon monoxide in the air. The monitor records lower levels that can impact your health but not necessarily threaten your life. Since CEHRC seeks to help communities identify potential health hazards as well as immediately life-threatening situations, we use an alarm that will sound at lower levels.

These alarms are available for between \$35 and \$50 at most hardware stores. *Make sure that the alarm records the peak level of carbon monoxide.* It costs a few dollars more but is essential for the test.

CEHRC has found three alarms that have these functions.

- Kidde Nighthawk Premium Plus® (Model # KN-COPP-3)
- SENCO Model One®
- First Alert Ultimate Carbon Monoxide Alarm® (Model # FCD4)

(These materials do not constitute endorsement of a particular product)

CEHRC uses the Kidde Nighthawk® since it is able to measure and display carbon monoxide levels as low as 11 parts per million (ppm) can run on battery back-up in the case of power failure, and is easy to use; SENCO® and First Alert® only measure levels of 30 ppm or greater. It is best for local organizations to select one model and stick with it to make it easier for the Hazard Investigators. Each model has different options and functions.

The accuracy of carbon monoxide alarms is dependent on atmospheric pressure, temperature and relative humidity. It is a good idea to develop a relationship with your local fire department so you can periodically check your meter against their more sophisticated (and more accurate) monitors. Your local fire department or gas company may be willing to donate (or subsidize the cost of) carbon monoxide alarms as part of its public education efforts or as a partner in your program.

Since every home burning wood or a “fossil fuel” should have a carbon monoxide alarm, your project might offer an alarm as an incentive for families to participate in the program.

Training and Qualifications:

No licensing or certification is required or needed to test for carbon monoxide. The testing process is relatively simple. Generally, CEHRC Home Hazard Investigators should receive CEHRC’s classroom training to follow the CEHRC Sampling Instructions, understand these background materials, follow the particular alarm’s instructions, know how to explain the results to the residents and understand the consequences of the results. The training should take about one hour. Hands-on training with an experienced investigator helps master the use of the alarm.

How to Use the CEHRC Carbon Monoxide Report

CEHRC’s Carbon Monoxide Report is designed to help the investigator record the results of the test. It is not part of the report to the residents. The highest reading recorded by the meter between visits should be recorded in the “Carbon Monoxide” section of the Sampling Results Report.

What Standards for Carbon Monoxide Apply?

There are no federal standards that apply to the air inside a home. Some state or local health or housing codes in regions with severe winters have standards for carbon monoxide.

Standards:

The World Health Organization guidelines for indoor air quality are that continuous carbon monoxide levels below 11 ppm are of limited or no concern, while levels above 32 ppm are of concern.

The Underwriters Laboratories® Standard UL2034 sets standards for carbon monoxide alarms to be used in residences. The alarms are designed to go off at levels that can cause immediate life threat.

Key Standards for Carbon Monoxide				
Agency	Situation	Protected Population	Maximum CO Level	Duration
Environmental Protection Agency (EPA)	Outdoor/Ambient Air	Everyone including children and the elderly	9 ppm	8 hours
			35 ppm	1 hour
Occupational Safety & Health Administration (OSHA)	Air in Workplace	Healthy adult employees	50 ppm	8 hours
National Institute for Occupational Safety and Health (NIOSH)	Air in Workplace	Healthy adult employees	35 ppm	8 hours
American National Standards Institute (ANSI)	Ventilation systems design and operation	Everyone	9 ppm	8 hours
			35 ppm	1 hour
Underwriter Laboratories (UL)	Alarms for Immediate Life Threats in Residential Air	Residents	70 ppm	1 to 4 hours
			150 ppm	10 to 50 min.
			400 ppm	4 to 15 min.
Canadian Department of National Health and Welfare	Air in Residences	Residents	11 ppm	8 hours
			25 ppm	1 hour
World Health Organization	Indoor Air	Everyone	32 ppm	Max.

What Do the Results Mean?

General Guidelines:

Any detectable level of carbon monoxide indicates that there may be a problem with an appliance or ventilation. The problem should be investigated. Levels that register on a carbon monoxide alarm could impair a person's health.

Sometimes the source is obvious: someone smokes in or near the home, or burns incense, or the car may be warming up in the garage. CEHRC hazard investigators test near appliances in order to help determine if there is an obvious source of carbon monoxide that can easily be fixed to prevent further carbon monoxide exposure in the home.

Enforcing Standards:

The U.S. Environmental Protection Agency (EPA) requires communities to reduce **outdoor** carbon monoxide levels if the levels exceed 9 ppm over one hour or 35 ppm over eight hours more than once a year. **These standards do not apply to indoor air.**

Since most people spend more time indoors than outdoors, our goal is for indoor air to at least meet EPA's outdoor air standard. This goal can be achieved if the fuel burning appliances are functioning properly and the home has good ventilation.

The American National Standards Institute (ANSI) and the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) recommend that ventilation systems be designed and operated so that indoors levels meet EPA's outdoor standards. This voluntary industry standard is widely respected and followed by engineers, architects and construction professionals. However, it is:

- ❑ Not enforceable unless incorporated into a state or local regulation; or
- ❑ Primarily used to guide new construction not force the repair of existing buildings;

Despite the lack of enforceable standards, knowing peak carbon monoxide levels is a powerful tool to get the problem fixed especially when you find high levels. Detectable carbon monoxide levels may be due to a heating or ventilation problem that is present in other units in the building – with levels that could be even more dangerous. Residents may be using space heaters or ovens when there are cold spots in the home caused by poor air circulation or insulation.

Most health departments, housing code inspectors, and gas companies understand the danger and should respond aggressively when notified. However, because these agencies may not understand that the Underwriters Laboratory standards are designed to address only life-threatening situations, they may not act if the levels are less than 70 ppm. They may discount the EPA outdoor standards even though those standards are designed to protect children and elderly from prolonged exposure. Therefore, CEHRC's approach is to use the alarm to find the location with highest level of carbon monoxide in the home and leave the alarm there to record the highest levels between visits.

The best potential allies are your state and local weatherization programs. In recent years, weatherization programs have taken steps to ensure that their efforts to "tighten" up the airflow in the

home will not cause problems with carbon monoxide and other hazards. They have developed a good understanding of the threat posed by carbon monoxide and may give special attention to a home with measurable levels. **Homes with carbon monoxide levels may be moved up the priority list for weatherization assistance, which may include replacing a damaged furnace or poor ventilation system.** Please note that weatherization programs have income limits for the residents so that landlords must charge affordable rents in order to qualify.

Please note that the Kidde Nighthawk® alarm records levels over 11 ppm. This detection limit is slightly higher than the EPA 8-hour standard of 9 ppm. If the indoor level averages over 9 ppm over eight hours, the level will most likely exceed 11 ppm for a short time and be recorded on the alarm.

Explaining the Results to Residents

Local organizations helping residents test for carbon monoxide in their homes should do the following:

- ❑ **If any carbon monoxide was detected,** advise the resident what the reading was. There may be a problem with an appliance or ventilation. The problem should be investigated. These levels could impair a person's vitality and health.

Residents should be asked not to smoke in the house and to let some fresh air in the home when burning incense. They should not warm up their car in the garage.

If an appliance is the likely cause, a heating, ventilation and air conditioning (HVAC) contractor should be called to investigate the furnace and appliances. Until the problem is fixed, the appliance should not be used.

- ❑ **If the carbon monoxide level is higher than 30 ppm,** the resident should turn off the appliance that is the most likely source, call the landlord or a heating, ventilation and air conditioning contractor, open the windows, and not use the appliance until it is repaired. If they are unsure of the source, they should call 911 and leave the home until the problem is fixed. They need to be cautious since they will have difficulty thinking clearly if exposed to high levels of carbon monoxide.
- ❑ **If the peak or current reading is over 70 ppm,** the resident should turn off the furnace and nearby appliances, call the landlord and/or gas company, open the windows, and leave the home until the alarm is repaired. If they are unsure of the source, they should call 911 and leave the home until the problem is fixed.
- ❑ **If no carbon monoxide was detected and they have fuel-burning appliances,** advise residents to:
 - Get a carbon monoxide alarm for each floor of their home. The most important place for the alarm is in the common area immediately outside the bedrooms. Make sure furniture or draperies cannot cover up that detector.
 - Make sure all the heating system is checked annually.

- Never burn charcoal inside a home or garage.
- Never use portable fuel-burning camping equipment inside a home or garage.
- Never leave a car running in an attached garage, even with the garage door open.
- Never use gas appliances such as ranges, ovens, or clothes dryers for heating the home.
- Never operate unvented fuel-burning appliances in any room with closed doors or windows or in any room where people are sleeping.

For more information that residents need to know about carbon monoxide and the alarm, please refer to the instructions and information that come with your particular carbon monoxide alarm, and be sure to leave a copy with the resident.

For More Information.....

Exposure Guidelines for Residential Indoor Air Quality, Canada Department of National Health and Welfare, Ottawa. April 1987.

Ventilation for Acceptable Indoor Air Quality, American National Standards Institute (ANSI), American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), Standard 62-2001, ISSN 1041-2336

World Health Organization, Report on a WHO meeting, August 21-24, 1984, Indoor Air Quality Research. EURO Reports and Studies 103, Regional Office for Europe, Copenhagen, Denmark, 1986.

Also, see CEHRC's Online Carbon Monoxide Resources for more information.

CARBON MONOXIDE: Assessment Checklist

BEFORE THE FIRST VISIT:

1. Test alarm with vehicle exhaust or a stick of incense.
2. Reset peak level reading.
3. Leave alarm on.

FIRST VISIT TO THE HOME:

4. Label carbon monoxide alarms in home on **Floor Plan**.
5. Close windows and open interior doors.
6. Have cars moved out of garage and check carbon monoxide levels in room closest to the garage while car is being moved.
7. Locate all gas or fuel burning appliances in home.
8. For each appliance:
 - Turn on appliance.
 - Check & record carbon monoxide levels near each appliance.
 - Reset peak level.
9. Place alarm in the area with highest reading.

SECOND VISIT TO THE HOME:

10. If any carbon monoxide was detected:
 - Tell the resident what the reading was.
 - Advise resident not to smoke in the house, let fresh air in the home when burning incense, and not to warm up their car in the garage with the garage door closed.
11. If carbon monoxide level is higher than 30 or 70 ppm, follow instructions found under **Information Resident Will Need**.
12. If no carbon monoxide was detected and they have fuel-burning appliances, advise the resident to:
 - Get a carbon monoxide alarm for each floor.
 - Check heating system annually.
 - Never burn charcoal or use portable fuel-burning camping equipment in the home or garage.
 - Never use gas appliances for heating home.
 - Never operate un-vented fuel-burning appliances in any room with close doors or windows or in any room where people are sleeping.
13. Collect alarm.

FOLLOW-UP

14. Prepare **Carbon Monoxide Report** and **Sampling Results Report** & deliver both to the resident.

Supplies:

- Kidde Nighthawk Carbon Monoxide Alarm[®]
- Alarm's instructions
- Carbon Monoxide Report
- Sampling Results Report
- Floor Plan
- Incense and lighter
- Spare battery

Information Resident Will Need:

- What alarm sounds like.
- If alarm goes off, the residents need to call emergency services, fire department or 911, immediately move to fresh air and stay there until after emergency services arrive.
- How to display current reading and peak level.
- Ask resident to check alarm and: if peak or current reading is over 30 ppm, they should turn off the appliance, call the landlord or a heating, ventilation and air conditioning contractor, open the windows, and not use the appliance until it is repaired. If not sure of source, they should call 911 and leave the home until the problem is fixed.
- Leave a copy of the alarm's manufacturers instructions, if practical, and a copy of CEHRC's fact sheet.
- The date and time of second scheduled visit (at least one week after first visit) to collect alarm.

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Assessment Instructions

CEHRC's Carbon Monoxide Assessment Instructions are intended to outline the steps CEHRC Home Hazard Investigators should take in order to assess homes for carbon monoxide problems. These materials complement CEHRC's carbon monoxide assessment training for community-based organizations working to improve housing conditions in high-risk communities through indoor environmental sampling activities.

These steps assume you have already decided which units to assess, completed the Visual Survey, have your supplies, have the resident's agreement to assess their home, and know how you plan to use the results. For more information on mold and moisture, please see the **Carbon Monoxide Background Materials** and **Carbon Monoxide Decision Guide**.

I. Supplies

The following supplies and equipment are used to test for carbon monoxide (CO). The alarms may be available at reduced or no cost through your local natural gas supplier or your local fire department, or else can be purchased at a hardware store.

- Choose a Carbon Monoxide alarm that:
 - Meets Underwriter Laboratory® Standard for residential carbon monoxide alarms – look for the UL in a circle logo on the container.
 - Is able to operate on battery power even temporarily.
 - Has a digital display of the measured carbon monoxide level.
- CEHRC uses the Kidde Nighthawk Carbon Monoxide Alarm ®

These sampling instructions assume you are using this alarm and will leave the alarm in the resident's home and return to pick it up. See Background Materials and Decision Guide for details on the alarm and procedure.

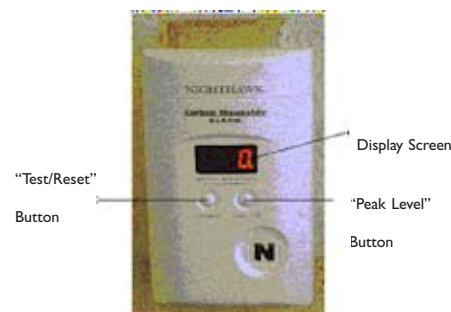
- Alarm's instructions (keep at least one copy for you and leave one for the resident)
- CEHRC Carbon Monoxide Report
- CEHRC Sampling Results Report
- Floor Plan
- Incense and lighter
- Spare battery

IA. FUNCTIONS OF THE KIDDE NIGHTHAWK CARBON MONOXIDE ALARM® - A QUICK TUTORIAL

- “Test/Rest Button is used to test the alarm, silence the alarm
 - To test the alarm, press the “test/reset” button. The alarm will be silent for approximately 15 seconds, beep 4 times, rest silent, and then sound 4 times again.
 - To silence the alarm when it is sounding, press the “test/reset” button.

- **“Peak Level” Button shows the peak level of carbon monoxide and is used to reset the peak level.**
 - To check the peak level of carbon monoxide, press the “peak level” button. This will display the highest carbon monoxide level that the alarm read the time the alarm was last reset or unplugged.
 - To reset the peak level, press the “peak level” button first. While still holding down the “peak level” button, press the “test/reset” button at the same time for approximately 2 seconds.

- **The display screen shows the level of carbon monoxide measured, whether the alarm is working, warming up, or has a low battery.**
 - The display screen shows the measurement of carbon monoxide.
 - When the red dot is blinking, the alarm is functioning.
 - When the display reads “888”, the alarm is warming up.
 - When the display reads “Lb,” the battery is low.



II. Avoid Common Mistakes

Check for “Zero”: Make sure the alarm shows no carbon monoxide reading when you turn it on. Read the alarm’s instructions. When the alarm is first turned on, it may take a few minutes for the alarm to “warm up”, during which the alarm will display “888”. Most alarms will display “0” or “ND” when

the levels are below the detection limit for the alarm (11 ppm for the recommended alarm).

Smoke Detectors and Fire Alarms are not Carbon Monoxide Alarms:

Smoke detectors and fire alarms do not alarm for carbon monoxide. Even if the resident tells you that she or he has a carbon monoxide alarm, check it to be sure.

Carbon Monoxide is not Carbon Dioxide: Carbon dioxide is different from carbon monoxide and much less dangerous. Outdoor air usually contains about 300 ppm of carbon dioxide while carbon monoxide levels should be less than 10 ppm.

Turn on fuel-burning appliances: If the furnace, water heater, space heater, stove or oven is not burning gas or fuel, it will not generate carbon monoxide. Turn the appliance on before checking for carbon monoxide.

Dead battery: While some alarms only need batteries, the Kidde Nighthawk Carbon Monoxide Alarm® runs on electricity and batteries. The battery is a back-up in case of power failure. The battery will last for only about 20 hours. If you leave the alarm in the home, plug it in to save the battery. This will also keep the resident from being disrupted when the alarm beeps as the battery runs dead. If the battery is low, the alarm will sound and display “Lb.” When the battery is dead, the alarm will not detect carbon monoxide.

Failing to reset peak reading: Make sure you reset the peak memory reading to zero when you leave the alarm in the home. If you don't reset it, you will be getting the peak level from when you last used the alarm. Reset the peak level by pressing the “peak level” button, then, while still **holding the “peak level” button, press the “test/reset” button for 2 seconds.**

III. Scheduling

Following the CEHRC protocol, local programs should leave a carbon monoxide alarm in the resident's home for **at least a week** in order to monitor carbon monoxide levels at different points in the day and night. Sampling for carbon monoxide requires two visits to the home if the Hazard Investigator will be leaving the alarm in the resident's home- one to do the initial check and set out the alarm. The second visit to pick up the alarm to see the peak level that was recorded.

For information on scheduling, refer to the **Carbon Monoxide Decision Guide**.

BEFORE THE FIRST VISIT

- ❑ **Check your alarm.** Before you enter the home, test your alarm outside to make sure it is working. You can do this indoors but be sure that you are away from potential sources of carbon monoxide such as a dryer or furnace exhaust. Since the alarm will make a loud noise when it goes off, test it away from people as well.
- ❑ **Turn on the carbon monoxide alarm to let it warm up.** The alarm will sound and then display “888” to indicate that it is warming up. After the warm-up cycle (approx. 20 seconds) it should indicate that there is no detectable level of carbon monoxide in outdoor air within a few minutes. The display should read “0” even when the “PEAK LEVEL” button is pushed. If it measures a level of carbon monoxide above zero, either the alarm is broken or outdoor levels are high. Use a second meter. In the unusual circumstance where outdoor levels are high, you may want to try again another day.
- ❑ **Use vehicle exhaust or a stick of incense to test the alarm.** Testing the alarm using car exhaust is a good way to check if the alarm is working since starting a cold car will release a high level of carbon monoxide. Very high levels of carbon monoxide and heat can damage the carbon monoxide alarm and carbon monoxide is dangerous. The Hazard Investigator should hold the alarm about 2 feet away from the vehicle’s exhaust pipe to avoid endangering their health and the functioning of the alarm. If the level is greater than 35 ppm, the reading will display. If the level is between 11 and 30 ppm, you must push the “PEAK LEVEL” button to see the measurement. The alarm cannot detect levels below 11 ppm.
 - Alternatively, you can use a stick of incense to test the alarm. Keep it at least a few inches away from the alarm - too much heat will damage the sensor. It may take a few minutes to register. You will probably get the alarm to sound because of the carbon monoxide being released from the smoldering heat of the incense burning.
Incense gives off smoke which can confuse people into thinking that you will know if you have a CO problem because you will be able to see smoke. It is important to reemember that CO is invisible and you may have CO present even without being able to see smoke
- ❑ **Reset the peak level reading** by pushing **both** the “PEAK LEVEL” button and the “TEST-RESET” button at the same time (holding them for about 2 seconds). The display should return to “0.”
- ❑ Don’t turn the alarm off. Let it run on battery power.
- ❑ Make sure the alarm is labeled as the property of your organization.

- You may also want to test (calibrate) your carbon monoxide alarm(s) occasionally against the more sophisticated equipment used by your local fire department or gas company.

IV. Sampling Instructions

1. Check to see if the home already has a carbon monoxide alarm on each floor of the building. Most homes do not have a carbon monoxide alarm. If you find one, check it to see if it works. If it has a working alarm, you should note where it is on the Floor Plan. Since this procedure checks levels that may not be recorded on most alarms, you may choose to continue with this procedure.

If time is short, you can skip steps 2-6 and place the carbon monoxide alarm in the kitchen or in a room next to an attached garage.

2. Close windows and open interior doors (doors that lead from room-to-room but not to the outside).

3. If there are cars in an attached garage, have the resident startup the car, drive it outside immediately and close the garage door while you take a reading. Starting a cold car will generate a great deal of carbon monoxide. Over time, some of that carbon monoxide will get into the home. **When the resident is moving the car, check the carbon monoxide levels in the room located closest to the attached garage.**

4. Locate all gas or fuel burning appliances in the home. Incomplete burning of natural gas, kerosene, fuel oil, coal or gasoline generates carbon monoxide. Appliances that only use electricity do not generate carbon monoxide. For example, look for the following appliances:

- Furnace
- Water heater
- Clothes dryer
- Oven
- Stove or range
- Space heater
- Fireplace

5. Turn on appliance. If an appliance has an exhaust fan (such as a stove), turn it on too. Let the appliance warm up.

6. Check and record carbon monoxide levels near each appliance. Place the alarm about 5 feet from the floor and 5 feet away from each appliance. Do not put the alarm directly in the exhaust pipe. Be sure to allow enough time for the appliance to warm up. After the appliance is warmed up, allow the alarm a few minutes to take a reading.

Because Underwriter Laboratories® does not allow a residential alarm to automatically display levels below 35 ppm, you may need to hold the “PEAK LEVEL” button in for the display to work. Record the peak level for each appliance on the Carbon Monoxide Report. Don’t forget to reset the peak level between each appliance.

7. Show the resident how to display the current reading and the peak reading.

8. Place the alarm in the area with the highest reading.

- a. Reset pushing “PEAK LEVEL” button and then the “TEST-RESET” button at the same time. The display should return to “0.”
- b. Plug the alarm into an outlet near the area where you had the highest reading. It should not be closer than 5 feet from the nearest fuel-burning appliance.
- c. Mark the location on the **Floor Plan** with “CO”.
- d. Show the resident where you put the alarm.

INFORMATION RESIDENT WILL NEED:

- What the alarm will sound like if it goes off. The alarm beeps 4 times, rests silent, beeps 4 times, and then repeats the cycle.
- If the alarm goes off, the residents need to call emergency services, fire department or 911. They need to immediately move to fresh air – outdoors or by an open door or window – and do a head check that all persons are accounted for. They should not go back into the home or move away from the fresh air (open window, etc.) until the emergency services arrive. *This important information is available on the alarm’s instructions that you should leave with the resident.*
- Where in the home you have placed the alarm.
- How to display the current carbon monoxide reading and the peak reading.
- How to replace the battery if the display shows “Lb.”
- Ask the resident to periodically check the alarm and:

- If the peak or current reading is over 30 ppm, they should turn off the appliance that is the most likely source, call the landlord or a heating, ventilation and air conditioning contractor, open the windows, and not use the appliance until it is repaired. **If they are unsure of the source, they should call 911 and leave the home until the problem is fixed.** They need to be cautious since they will have difficulty thinking clearly if exposed to high levels of carbon monoxide.
- If the peak or current reading is over 70 ppm, turn off the furnace and nearby appliances, call the landlord and/or gas company, open the windows, and leave the home until the alarm is repaired. **If they are unsure of the source, they should call 911 and leave the home until the problem is fixed.**
- In addition, if practical, leave a copy of the alarm's manufacturers instructions with the resident, as well as a copy of CEHRC's fact sheet **Having your Home Checked for Health Hazards.**
- When you plan on returning. Be sure to schedule a second visit for at least one week after the first visit to collect the alarm.

ON THE RETURN VISIT TO COLLECT THE ALARM:

- If no carbon monoxide was detected and they have fuel-burning appliances, advise residents to:
 - Get a carbon monoxide alarm for each floor of their home. One of the alarms should be located in or near the bedrooms. Make sure furniture or draperies cannot cover up that detector.
 - Make sure all of the heating system is checked annually.
 - Never burn charcoal inside a home or garage.
 - Never use portable fuel-burning camping equipment inside a home or garage.
 - Never leave a car running in an attached garage, even with the garage door open.
 - Never use gas appliances such as ranges, ovens, or clothes dryers for heating the home.
 - Never operate un-vented fuel-burning appliances in any room with closed doors or windows or in any room where people are sleeping.

- ❑ **If any carbon monoxide was detected**, tell the resident what the reading was. There may be a problem with an appliance or ventilation. If someone smokes in or near the home or burns incense, carbon monoxide may be detected. In some cases, the alarm may sound. In either case, the problem should be investigated. These carbon monoxide levels could harm a person's health.

Advise residents not to smoke in the house and to let fresh air in the home when burning incense. They should not warm up their car in the garage with the garage door closed.

If an appliance is the likely cause, a heating, ventilation and air conditioning (HVAC) contractor should be called to investigate the furnace and appliances. Until the problem is fixed, the appliance should not be used.

- ❑ **If the carbon monoxide level is higher than 30 ppm**, the resident should turn off the appliance that is the most likely source, call the landlord or a heating, ventilation and air conditioning contractor, open the windows, and not use the appliance until it is repaired. **If they are unsure of the source, they should call 911 and leave the home until the problem is fixed.** They carbon monoxide.
- ❑ If the peak or current reading is over 70 ppm, the resident should turn off the furnace and nearby appliances, call the landlord and/or gas company, open the windows, and leave the home until the alarm is repaired. If they are unsure of the source, they should call 911 and leave the home until the problem is fixed.

FOLLOW-UP

Prepare the **Carbon Monoxide Report** and **Sampling Results Report** and deliver both to the resident.

CARBON MONOXIDE

Decision Guide

This guide is intended for project managers considering whether they want to measure carbon monoxide levels in homes and, if so, what homes should be the focus of their efforts. The **Carbon Monoxide Assessment Instructions** provide step-by-step instructions that the Hazard Investigator needs. CEHRC's **Carbon Monoxide Background Materials** offer additional information.

- ❑ **Why test for carbon monoxide (CO)?** Carbon monoxide is an odorless, colorless gas that starves your body of oxygen. You get tired, sluggish and drift into sleep. Each year, more than 200 Americans accidentally die from carbon monoxide poisoning unrelated to fires and engine exhaust. 76% of these deaths are from heating systems. Beyond deaths, more than 10,000 people visit the emergency room each year due to accidental carbon monoxide poisoning from consumer products. 56% of these cases are caused by heating systems and 4% by gas water heaters.

In the winter when homes are closed up tight to keep the cold out and fuel-burned heat in, low levels of carbon monoxide can cause flu-like symptoms and make it difficult to think clearly. Children, the elderly, and people with respiratory problems or heart disease are especially sensitive. Residential carbon monoxide alarms do not alarm at these lower levels that aggravate chronic health problems.

- ❑ **Which Homes should be checked?** All homes should be checked, but top priority should be given to homes with gas heat and gas appliances, especially homes that are poorly cared for or if residents report that they use an oven or space heater for heat.
- ❑ **What training is required?** Home Hazard Investigators should receive classroom training to follow the CEHRC Sampling Instructions, understand the Background Materials, how to follow the equipment's instructions, and how to deliver the results to residents. The training should take about one hour. Hazard Investigators should be monitored on the job for at least the first couple of homes they check to make sure they are following the procedure properly.

CEHRC recommends that project staff talk with the local fire department and gas company since they may be a valuable resource for information and guidance on local problems.

- ❑ **How much does it cost?** A suitable carbon monoxide alarm costs less than \$50 at most hardware stores. The alarm can be used for five years. The alarm must be able to run on battery power, have a digital readout and store the highest reading. CEHRC uses the Kidde Nighthawk® alarm because it records lower levels of carbon monoxide in the home than the others and is easy to use and read. Program managers may want to leave an alarm at homes for several months if the home has detectable levels of carbon monoxide and the landlord is slow in fixing the problem.
- ❑ **Any limits on scheduling of visits?** CEHRC recommends scheduling carbon monoxide testing for winter months when homes are closed up and the heat is on. Sampling in warmer months may give residents a false sense of security because the alarm will register lower carbon monoxide levels than in the winter months when the furnace is running and the home has less fresh air coming in. The alarm could still be used around appliances used to heat to indicate possible leaks in exhaust of appliances or from an attached garage that could affect

the family year-round, and allow the family time to have the problem fixed before the home is closed up for the winter.

Following the CEHRC protocol local programs should leave the carbon monoxide alarm in the resident's home for at least a week in order to get a good sense of the carbon monoxide problem a home may have. In this case, two visits are needed. One to check around the home for carbon monoxide and to place the alarm and set up the alarm and the second to pick up the alarm and check to determine the highest carbon monoxide level recorded between visits. Checking gas appliances for carbon monoxide can take 10-30 minutes, depending on the number of appliances. If the Hazard Investigator does not have enough time, to monitor the air between visits. It is likely that the kitchen is where carbon monoxide levels would be identified.

- Are there standards?** Yes, there are many standards for carbon monoxide exposure but none are directly binding on the home. EPA has health-based standards for carbon monoxide, but these only apply outdoors. Underwriter Laboratories® sets standards for carbon monoxide alarms, but these standards are designed to address life-threatening situations.

Agency	Situation	Protected Population	Max. CO Level	Duration
Environmental Protection Agency (EPA)	Outdoor/ Ambient Air	Everyone including children and the elderly	9 ppm	8 hours
			35 ppm	1 hours
Underwriter Laboratories (UL)	Residential Air - Immediate Threat to Life	Everyone, but only from exposure that is life threatening.	70 ppm	1 to 4 hours
			150 ppm	10 to 50 min.
			400 ppm	4 to 15 min.

Some local health or housing codes in northern cities with severe winters may set other standards, so CEHRC recommends looking into your local code as well.

- How useful are the results?** The results are a powerful tool to get the problem fixed especially when you find high levels. In multi-unit buildings, detectable carbon monoxide levels in one unit or area may be due to a heating or ventilation problem that is present in other units in the building, where levels could be even more dangerous. Also, residents may be using space heaters or ovens when there are cold spots in the home caused by poor air circulation or insulation.

Most health departments, housing code inspectors, and gas companies understand the hazard and should respond aggressively when notified. However, because these agencies may not understand that the UL standards are designed to address only life-threatening situations, they may not act if the levels are less than 70 ppm.

One potential ally is your state and local weatherization program. The home may be moved up the priority list for weatherization assistance and that assistance is likely to include replacing

a damaged furnace or poor ventilation system. Please note that weatherization programs have income limits for the residents and may put rent conditions on the landlord that some landlords may object to.

- ❑ **Are there any safety concerns to Hazard Investigators?** Not really. The Home Hazard Investigator might be exposed to carbon monoxide before the alarm would sound. However, the exposures are so short that it is not a significant concern. If there was an extremely high level of carbon monoxide, the alarm should alarm within four minutes.

- ❑ **What other potential downsides must be considered?** If the Home Hazard Investigator finds levels over 30 ppm, he or she must be prepared to react quickly. You should have a plan to deal with these situations. You need to alert the residents to the urgent problem. You may also have an obligation to report high carbon monoxide levels to the local health department.

Carbon Monoxide Report

Date Monitor Placed in Home: _____

Placed by: _____

Date Monitor Removed from Home: _____

Removed by: _____

Resident: _____

Address: _____

Unit #: _____ Phone #: _____

Notes: _____

Appliance	Room	Electric / Natural Gas / Other	If appliance burns natural gas, kerosene or other fuel		
			Exhaust is vented outside	Highest carbon monoxide (ppm)	Location of highest reading
Furnace					
Water Heater					
Stove/Oven					
Space Heater					
Clothes Dryer					
Other					

_____ Peak Reading on Monitor (Second Visit)

Checks:

- Monitor showed no detectable level of carbon monoxide outside building during **FIRST** visit.
- Monitor showed a detectable level of carbon monoxide when checked with an incense/vehicle exhaust.
- Monitor showed no detectable level of carbon monoxide outside building during **SECOND** visit.