Carbon Monoxide Detection in Buildings
Frequently Asked Questions

What is carbon monoxide?

Carbon monoxide (CO) is a colorless, odorless, tasteless, poisonous gas that is produced by the incomplete burning of various fuels, including coal, wood, charcoal, oil, kerosene, propane, and natural gas. Equipment powered by internal combustion engines—for example, portable generators, lawn mowers, and power washers—produces carbon monoxide.

Through the process of respiration, oxygen enters the lungs and is transported by hemoglobin in the blood to various organs and tissues in the body, such as the heart and brain. When CO is inhaled, it enters the bloodstream and attaches to hemoglobin, forming the COHb molecule. COHb reduces the ability of the blood to carry oxygen to vital organs by preventing the oxygen molecule from attaching to hemoglobin.

What are the symptoms of carbon monoxide poisoning?

Because carbon monoxide has no odor, color, or taste and is otherwise undetectable by human senses, people may not realize they are being exposed to the "silent killer." The extent of its effects on an exposed person's health depends on the length of exposure, blood concentration levels, and personal health conditions.

Children, the elderly, and people with heart and lung diseases are particularly vulnerable to elevated levels of CO, and therefore poisoning can occur more rapidly in them than in normal, healthy adults. The symptoms of CO poisoning at low to moderate concentrations are similar to those of the flu and include the following:

- Headaches
- Dizziness
- Sleepiness
- Nausea
- Vomiting
- Shortness of breath
- Mental confusion
- Disorientation

At high concentrations in the blood, CO can cause:

- Cognitive impairment
- Loss of muscle coordination
- Loss of consciousness
- Coma
- Death

The U.S. Centers for Disease Control and Prevention (CDC) estimates that more than 400 people in the U.S. die from accidental CO poisoning each year. In addition, over 20,000 are injured or suffer illness from CO poisoning each year. Because symptoms are similar to the flu, CO deaths and injuries have been severely underreported and, according to some estimates, actual deaths

may exceed 2,000. Even when there are not deaths, long-term effects on the nervous system and heart can occur in as many as 40% of the cases.

What are common or potential sources of carbon monoxide in buildings?

There are several potential sources of carbon monoxide that could be present in a building:

- Heating systems (HVAC—gas-fired, oil-fired, central, and unitary equipment)
- Gas-fired appliances (e.g., ranges, ovens) found in kitchens and cafeterias
- Gas-fired washing machines and clothes dryers
- Gas-fired water heaters and boilers
- Vehicles left running in a loading dock
- Use of gas-fired power tools in a school building (e.g., by janitorial staff, in shop classes)

Exposure of building occupants to CO is determined by their proximity to the CO-emitting source and/or the configuration of the building's HVAC systems.

How often do carbon monoxide exposure incidents occur in buildings?

The National Fire Protection Association (NFPA) conducted an analysis of non-fire CO incidents reported for the years 2006–2010, which showed 16,570 total CO incidents reported nationwide in apartment/multi-family dwelling and non-dwelling occupancies.[1] However, it is difficult to quantify the exact number of CO incidents in such occupancies. Due to the fact that carbon monoxide affects each individual differently and symptoms of exposure mimic those of common ailments such as the flu, it is highly probable that the number of CO exposure incidents has been underreported.

Are older buildings more likely to experience carbon monoxide leaks?

A common perception is that older buildings likely contain older fossil fuel-burning furnaces, boilers, appliances, etc. As equipment ages, the potential for malfunction increases, particularly if the equipment is not routinely inspected and properly maintained.

How much does it cost to install carbon monoxide detection systems in buildings?

The cost depends on the type of carbon monoxide detection and warning equipment installed. Generally, it is less expensive to install single- or multiple-station alarms than system-connected carbon monoxide detectors, but detectors offer an advantage in that they are capable of sending signals to a remote supervising station or constantly attended onsite location, ensuring continual monitoring, immediate notification, and timely response. System-connected detectors may be either part of a standalone CO detection control or combined with an existing fire alarm system or security system. For commercial occupancies, system-connected CO detectors are typically combined with an existing fire alarm system. To that end, the cost of installing CO

[1] National Fire Protection Association, "Non-Fire Carbon Monoxide Incidents" (2012), Table A, pg. 1.

detection in existing occupancies generally depends on whether or not it can be added to systems already in place.

What are the key differences between carbon monoxide alarms and carbon monoxide detectors?

Most carbon monoxide alarms and detectors available on the market are listed by an independent, nationally recognized testing laboratory (NRTL) accredited by the U.S. Occupational Safety and Health Administration (OSHA) to comply with one of the two product standards published by Underwriters Laboratories Inc. (UL). Such standards are developed according to the standards development guidelines adopted by the American National Standards Institute (ANSI).

Carbon monoxide alarms can be single- or multiple-station units that detect carbon monoxide and are either hardwired into the building's AC power, operated by a battery, or plugged into an electrical outlet (generally with battery backup). Single-station alarms are detectors that incorporate a sensor, control components, and an alarm notification appliance in one unit operated from a power source either located in the unit or obtained at the point of installation. Multiple-station CO alarms are single-station alarms capable of being interconnected to one or more additional alarms so that the actuation of one causes the appropriate alarm signal to operate in all interconnected alarms. All such alarms are listed for compliance with ANSI/UL 2034 *Standard for Single- and Multiple-Station Carbon Monoxide Alarms.* Alarms that combine carbon monoxide and smoke detection in a single unit are also available.

Carbon monoxide detectors are devices connected to an alarm control unit having a sensor that responds to carbon monoxide. These system-connected carbon monoxide detectors and sensors generally are listed for compliance with ANSI/UL 2075 *Standard for Gas and Vapor Detectors and Sensors.*

In general, single- or multiple-station carbon monoxide **alarms**

- are lower in cost per unit than CO detectors;
- do not have the capability of sending an alert to a remote supervising station or constantly attended onsite location, instead relying on individuals to hear and respond to alarms;
- must be replaced when the device reaches end of life (typical life of sensor); and
- could be used as an alternative to CO detectors in existing construction in an effort to control costs.

In general, system-connected carbon monoxide **detectors**

- transmit signals to an approved remote supervising station or constantly attended onsite location, allowing for timely notification and response to CO incidents;
- can be operated as a stand-alone system or combined with either a new or existing fire alarm system or security system;

- should be required in new construction;
- are higher in cost per unit than CO alarms; and
- must be replaced when the device has reached its end-of-life (typical life of sensor).

For new construction in commercial occupancies, system-connected carbon monoxide detectors should be required, as the cost is minimal when included in the initial planning and estimates. CO detection can be incorporated with other life safety systems.

For existing construction in commercial occupancies, system-connected CO detectors are preferable for the advantage they offer in being able to send alerts to constantly attended onsite locations or approved remote supervising stations. However, acknowledging budgetary constraints and the need to control costs, single- or multiple-station alarms may be considered as an alternative, provided someone will be in a position to hear and/or respond to them should they signal.

What is the life span of carbon monoxide alarms and detectors?

Although the UL standard requires a three-year sensor, the life spans of commercially available carbon monoxide alarms and detectors range between 6 and 10 years because the CO gas-sensing element of the device is considered a limited-life component. Therefore, ANSI/UL 2034 requires the CO alarm to indicate an audible end-of-life signal that is different from the alarm signal. ANSI/UL 2075 requires the CO detector to send an end-of-life signal to the control unit and the remote supervising station. The end-of-life signal is triggered either by an internal timer or by a self-diagnostic test.

What is NFPA 720 and why should it be cited in a statute?

NFPA 720 *Standard for the Installation of Carbon Monoxide Detection and Warning Equipment*[2] covers the selection, design, application, installation, location, performance, inspection, testing, and maintenance of carbon monoxide detection and warning equipment, including single- and multiple-station carbon monoxide alarms and carbon monoxide detectors and their related systems and components.

The 2015 edition of NFPA 720 should be cited in statute because it provides a performance-based alternative to prescriptive location requirements, thereby giving greater latitude to the state agency or entity responsible for implementing and enforcing the requirements. Previous versions of NFPA 720 required CO detectors to be located on the ceiling above permanently installed fuel-burning appliances, on every floor, and in every HVAC zone in commercial buildings; however, it may not be necessary to install CO detection on every floor and in every HVAC zone if the upper floors or other areas of the building are not connected by duct work or ventilation shafts to a room containing a fuel-burning appliance. To that end, the 2015 edition of 720 permits a performance-based alternative that would allow the state agency some leeway

[2] As of the writing of this document, NFPA 720 is being considered for incorporation into NFPA 72 *National Fire Alarm and Signaling Code*.

in determining precise location requirements. They could then choose to model the location requirements for the building after the current requirements in section 28.3.4.6 of the 2015 edition of NFPA 101 *Life Safety Code* for CO detection in hotels as a basis:

- In rooms containing a fuel-burning appliance (FBA)
- In sleeping rooms with an FBA (if applicable)
- Centrally located within occupiable spaces served by the first supply air register from a permanently installed FBA HVAC system
- Centrally located within occupiable spaces adjacent to a communicating attached garage

How are these product (ANSI/UL 2034 and ANSI/UL 2075) and installation (NFPA 720) standards promulgated? Why are they important?

Voluntary national consensus standards such as NFPA 720, ANSI/UL 2034, and ANSI/UL 2075, and subsequent code provisions, are the leading edge of verification and durability of many products. Life safety codes and standards ensure that products meet crucial performance requirements.

The American National Standards Institute (ANSI) accredits U.S. voluntary consensus standards. The organization oversees the creation, promulgation, and use of thousands of U.S. standards by accrediting the procedures of standards developing organizations, such as Underwriters Laboratories, Inc. (UL) and the National Fire Protection Association (NFPA). Accreditation by ANSI signifies that standards developers are consistently adhering to *ANSI Essential Requirements* to ensure a balanced and consensus-based approval process. There are a number of key elements of the process:

- Consensus must be reached by representatives from materially affected and interested parties
- Standards are required to undergo public reviews, during which period any member of the public may submit comments
- Comments from the consensus body and public review commenters must be responded to in good faith
- An appeals process is required

Codes and standards drafting and acceptance follow regularly scheduled review that incorporates the best thinking and state-of-the-art developments.

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Communication Section manufacture fire, smoke, and carbon monoxide detection and warning equipment.

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