

NFPA 720

Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment

2003 Edition



NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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NFPA 720

Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment

2003 Edition

This edition of NFPA 720, *Recommended Practice for the Installation of Household Carbon Monoxide (CO) Warning Equipment*, was prepared by the Technical Committee on Carbon Monoxide Detection and acted on by NFPA at its November Association Technical Meeting held November 16–20, 2002, in Atlanta, GA. It was issued by the Standards Council on January 17, 2003, with an effective date of February 6, 2003, and supersedes all previous editions.

This edition of NFPA 720 was approved as an American National Standard on January 17, 2003.

Origin and Development of NFPA 720

With the increased concern over carbon monoxide (CO) hazards in residential applications, the National Fire Protection Association was petitioned to develop a document covering the installation of CO detectors and related equipment. In late 1993, the Technical Committee on Household Fire Warning Equipment was tasked to develop a document covering the installation and use of CO detectors. This document was originally prepared by the Technical Committee on Household Fire Warning Equipment but was returned to committee at the 1995 Annual Meeting. The NFPA Standards Council later approved the formation of the Technical Committee on Carbon Monoxide and Fuel Gas Detectors to further develop this document.

The 2003 edition reflects editorial revisions to comply with the latest edition of the *Manual of Style for NFPA Technical Committee Documents*. These revisions include the addition of three administrative chapters at the beginning of the document: “Administration,” “Referenced Publications,” and “Definitions.” Two technical chapters follow the administrative chapters: “General Provisions” from Chapter 1 (in part) of the 1998 edition and “Household Carbon Monoxide Warning Equipment” from Chapter 2 of the 1998 edition. Editorial revisions also include the breakout of paragraphs with multiple requirements into individually numbered paragraphs, the minimization of the use of exceptions, and the use of consistent headings for sections and section subdivisions. Changes have also been made in some locations to provide language and terminology that is more consistent and user-friendly.

The 2003 edition also contains technical revisions. Included among these are the additional recommendation that printed instructions for carbon monoxide alarms and detectors include minimum and recommended distances from fuel-burning appliances, and the inclusion of additional information on the symptoms of carbon monoxide exposure based on percentage of carboxyhemoglobin.

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Committee Scope: This Committee shall have primary responsibility for documents addressing the selection, installation, operation, and maintenance of carbon monoxide warning equipment.

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, Annex C lists the complete title and edition of the source documents for both mandatory and nonmandatory extracts. Editorial changes to extracted material consist of revising references to an appropriate division in this document or the inclusion of the document number with the division number when the reference is to the original document. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope.

1.1.1 This document is primarily concerned with life safety, not with protection of property.

1.1.2* This document is limited to carbon monoxide warning equipment for use in family living units that contain fuel-burning appliances or fireplaces or have attached garages.

1.1.3 This document contains recommendations for the selection, installation, operation, and maintenance of equipment that detects concentrations of carbon monoxide that could pose a risk to the health of most occupants in family living units.

1.2 Purpose.

1.2.1* The purpose of this document is to provide a warning of the presence of carbon monoxide in sufficient time to allow occupants to either escape or take other appropriate action.

1.2.2 Although carbon monoxide warning equipment might respond to gases produced by unwanted fires, it is not fire warning equipment and should not be used in lieu of fire warning equipment required by *NFPA 72®*, *National Fire Alarm Code®*, or *NFPA 101®*, *Life Safety Code®*.

1.3 Equivalency. Nothing in this recommended practice is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those recommended by this document.

1.3.1 Technical documentation should be submitted to the authority having jurisdiction to demonstrate equivalency.

1.3.2 The system, method, or device should be approved for the intended purpose by the authority having jurisdiction.

1.3.3 All alarms or detectors and related equipment having materials or forms different from those detailed in this document should be examined and tested in accordance with applicable standards and, if found equivalent, should be permitted to be approved.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this recommended practice and should be considered part of the recommendations of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Box 9101, Quincy, MA 02269-9101.

NFPA 70, *National Electrical Code®*, 2002 edition.

NFPA 72®, *National Fire Alarm Code®*, 2002 edition.

NFPA 101®, *Life Safety Code®*, 2003 edition.

2.3 Other Publications.

2.3.1 UL Publication. Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Detectors*, October 29, 1996.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter apply to the terms used in this recommended practice. Where terms are not included, common usage of the terms applies.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Recommended Practice. A document that is similar in content and structure to a code or standard but that contains only nonmandatory provisions using the word “should” to indicate recommendations in the body of the text.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Alarm.

3.3.1.1 Carbon Monoxide Alarm. A single or multiple station alarm responsive to carbon monoxide.

3.3.1.2 Multiple Station Alarm. A single station alarm with the added capability 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. [72:3.3]

3.3.1.3 Single Station Alarm. A detector comprising an assembly that incorporates 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. [72:3.3]

3.3.2 Detector.

3.3.2.1 Carbon Monoxide Detector. A device suitable for connection to a circuit having a sensor that responds to carbon monoxide and does not contain an integral notification appliance.

3.3.2.2 Multiple Purpose Detector. A detector that incorporates detection capabilities for more than one hazardous condition, such as fire, fuel gas, or carbon monoxide.

3.3.3* Family Living Unit. One or more rooms in a single-family detached dwelling, single-family attached dwelling, multifamily dwelling, or mobile home for the use of one or more persons as a housekeeping unit with space for eating, living, and sleeping and permanent provisions for cooking and sanitation.

3.3.4 Fireplace. A hearth, fire chamber, or similarly prepared area and a chimney. [211:3.3]

3.3.5* Fuel-Burning Appliance. A device that burns solid, liquid, or gaseous fuel or a combination thereof.

3.3.6 Notification Appliance. An alarm system component such as a bell, horn, speaker, strobe, or printer that provides audible or visible output, or both.

3.3.7 Reliable Component. A component that is not expected to fail or be periodically replaced and that is not monitored.

3.3.8 Response Plan. The action to be taken in response to an alarm signal.

3.3.9* Separate Sleeping Area. The area of a family living unit where the bedrooms or sleeping rooms are located.

3.3.10 Signal.

3.3.10.1 Alarm Signal. A signal indicating a concentration of carbon monoxide that could pose a risk to the life safety of the occupants in the family living unit, and requiring immediate action.

3.3.10.2 Trouble Signal. An indication distinct from the alarm signal that warns of a malfunction or failure.

3.3.11 System. One or more detectors that are interconnected with remotely located devices or components and that have the ability to function interdependently.

Chapter 4 General Provisions

4.1 Warning Functions. The warning functions intended in this recommended practice can be performed by single or multiple station alarms or by detectors connected to a control unit and associated equipment, or any combination thereof.

4.2 Supplemental Functions. Supplemental functions, including the transmission of an alarm beyond the household, should be permitted and should not interfere with the performance recommendations of this document.

4.3 Total System. Where the AHJ requires both the alarm transmission beyond the household and the total system to comply with the applicable sections of *NFPA 72®*, *National Fire Alarm Code®*, the recommendations of Section 5.1 and 5.4.2 of this document should be followed.

4.4 Equipment. All alarms or detectors and related equipment to be installed in conformity to this recommended practice should be listed or approved for the purpose for which they are used.

Chapter 5 Household Carbon Monoxide Warning Equipment

5.1 Recommended Protection.

5.1.1* Carbon Monoxide Alarm.

5.1.1.1* A carbon monoxide alarm or detector should be centrally located outside of each separate sleeping area in the immediate vicinity of the bedrooms.

5.1.1.2 Where sleeping areas are separated and the audibility of the alarm or detector to occupants within each sleeping area could be seriously impaired, more than one unit could be needed.

5.1.1.3 Each alarm or detector should be located on the wall, ceiling, or other location as specified in the installation instructions that accompany the unit.

5.1.2 Alarm Notification Appliances. Each alarm or detector should cause the operation of an alarm notification appliance that should be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

5.1.3 Alarm Notification Appliances for the Hearing Impaired.

5.1.3.1 In a household occupied by one or more hearing-impaired persons, each initiating device should cause the operation of a visible alarm signal in accordance with 5.3.3 or the operation of a listed tactile notification appliance.

5.1.3.2 The responsibility for compliance with 5.1.3.1 should be that of the householder.

5.2 Power Supplies.

5.2.1 General.

5.2.1.1 All power supplies should have sufficient capacity to operate the alarm signal(s) for at least 12 continuous hours.

5.2.1.2 For electrically powered household carbon monoxide warning equipment, the primary (main) power source should be ac, unless otherwise permitted by the following:

- (1) Detectors and alarms are permitted to be powered by a monitored dc circuit of a control unit when power for the control unit meets the recommendations of Section 5.2 and the circuit remains operable upon loss of primary (main) ac power.
- (2) A detector and a wireless transmitter that serves only that detector are permitted to be powered from a monitored battery primary (main) source where part of a listed, monitored, low-power radio (wireless) system.
- (3) In existing construction, a monitored battery primary (main) power source, as described in 5.2.3, is permitted.

5.2.2 Primary Power Supply — ac.

5.2.2.1 An ac primary (main) power source should be a commercial light and power supply or other dependable source.

5.2.2.2 A visible “power on” indicator should be provided.

5.2.2.3 Primary (main) ac power should be supplied from either a dedicated branch circuit or the unswitched portion of a branch circuit also used for power and lighting.

5.2.2.4 All electrical systems designed to be installed by other than a qualified electrician should be powered from a source not in excess of 30 volts that meets the requirements for Class 2 circuits as defined in Article 725 of NFPA 70, *National Electrical Code*®.

5.2.2.5 A restraining means should be used at the plug-in of any cord-connected installation.

5.2.2.6 Operation of a switch (other than a circuit breaker) or a ground fault circuit interrupter should not cause loss of primary (main) power.

5.2.2.7 The recommendation of 5.2.2.6 does not apply where a ground fault circuit interrupter serves all electrical circuits within the household.

5.2.2.8 Neither loss nor restoration of primary (main) power should cause an alarm signal exceeding two seconds.

5.2.2.9 Where a secondary (standby) battery is provided, the primary (main) power supply should be of sufficient capacity to operate the system under all conditions of loading with any secondary (standby) battery disconnected or fully discharged.

5.2.3 Primary Power Supply — Monitored Battery. Household carbon monoxide warning equipment should be permitted to be powered by a battery, provided that the battery is monitored to ensure that the following conditions are met:

- (1) All power recommendations are met for at least one year of battery life, including monthly testing.
- (2) A distinctive audible trouble signal sounds before the battery is incapable of operating the device(s) (from causes such as aging or terminal corrosion) for alarm purposes.
- (3) Automatic transfer is provided from alarm to a trouble condition for a unit employing a lock-in alarm feature.
- (4) The unit is capable of producing an alarm signal for at least 12 hours at the battery voltage at which a trouble signal is normally obtained, followed by not less than 7 days of trouble signal operation.
- (5) After the initial 4 minutes of alarm, the 5-second “off” time of the alarm signal should be permitted to be changed to 60 seconds $\pm$ 10 percent.

- (6) The audible trouble signal is produced at least once every minute for 7 consecutive days.
- (7) Acceptable replacement batteries are identified by the manufacturer’s name and model number on the unit near the battery compartment.
- (8) A visible indication is displayed when a primary battery is removed from the unit.
- (9) Any unit that uses a non-rechargeable battery as a primary power supply that is capable of a 10-year or greater service life, including testing, and meets the recommendations of this section should not require a replaceable battery.
- (10) A visible “power on” indicator should be provided.

5.2.4 Secondary (Standby) Power Supply.

5.2.4.1 When provided, a secondary (standby) power supply should have sufficient capacity to power the unit for 8 hours, followed by not less than 12 hours of alarm, followed by not less than 7 consecutive days of trouble signals.

5.2.4.2 After the initial 4 minutes of alarm, the 5-second “off” time of the alarm signal should be permitted to be changed to 60 seconds $\pm$ 10 percent.

5.2.4.3 Removal or disconnection of a battery used as a secondary (standby) power source should cause an audible or visible trouble signal.

5.2.4.4 Acceptable replacement batteries should be identified by manufacturer’s name and model number on the unit near the battery compartment.

5.2.4.5 Where required by law for disposal reasons, rechargeable batteries should be removable.

5.2.4.6 An audible trouble signal should sound before the battery is incapable of operating the device(s) (from causes such as aging, discharge, or terminal corrosion) for alarm purposes.

5.2.4.7 Automatic recharging should be provided when a rechargeable battery is used as a secondary (standby) supply.

5.2.4.8 Where automatic recharging is provided, the battery should be recharged within one of the following time periods:

- (1) Within 4 hours where power is provided from a circuit that can be switched on or off by means other than a circuit breaker
- (2) Within 48 hours where power is provided from a circuit that cannot be switched on or off by means other than a circuit breaker

5.3 Equipment Performance.

5.3.1 Carbon Monoxide Alarms.

5.3.1.1 Each carbon monoxide alarm should detect abnormal carbon monoxide levels that could occur in a family living unit.

5.3.1.2 Each carbon monoxide alarm should operate in the normal environmental conditions of a household.

5.3.1.3 Each carbon monoxide alarm should be in compliance with UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Detectors*, which includes a level below which the alarm should not respond.

5.3.1.4 All signals produced from periodic testing of carbon monoxide alarms or detectors (*see* 5.5.2) should be identical with the signal produced when the unit is in alarm.

5.3.2 Audible Alarm Signals.

5.3.2.1 All alarm sounding appliances should have a minimum rating of 85 dBA at 3 m (10 ft).

5.3.2.2 The audible alarm signal for carbon monoxide alarms should be a single tone pattern consisting of four cycles of 100 milliseconds $\pm$ 10 percent “on” and 100 milliseconds $\pm$ 10 percent “off,” followed by 5 seconds $\pm$ 10 percent “off.”

5.3.2.3 After the initial 4 minutes of alarm, the 5-second “off” time should be permitted to be changed to 60 seconds $\pm$ 10 percent.

5.3.2.4 The alarm signal should be repeated in compliance with 5.3.2.2 and 5.3.2.3 until the alarm resets or the alarm signal is manually silenced.

5.3.3 Visible Alarm Signals.

5.3.3.1 Visible notification appliances used in rooms where a hearing-impaired person sleeps should have a minimum rating of 110 candela and be mounted within 4.8 m (16 ft) of the pillow.

5.3.3.2 Visible notification appliances in other than sleeping rooms should have a minimum rating of 15 candela.

5.3.4 Multiple Purpose Alarms.

5.3.4.1 A fire alarm signal should take precedence or be distinctively recognizable over any other signal, even when the non-fire signal is initiated first.

5.3.4.2 There should be a means for distinguishing the carbon monoxide alarm signal from all other signals.

5.3.5 Interconnecting Initiating Devices.

5.3.5.1 Multiple station alarms should be permitted to be interconnected provided that the multiple station alarm devices are compatible.

5.3.5.2 A single fault on the wiring connecting the alarms should not prevent the independent operation of any of the interconnected alarms.

5.3.5.3 The test feature on any alarm device should cause all interconnected alarms to activate the appropriate alarm signal.

5.3.6 Control Equipment.

5.3.6.1 Control equipment should be automatically restored upon restoration of electrical power.

5.3.6.2 The control equipment should be of a type that “locks in” on an alarm condition.

5.3.6.3 When a reset switch is provided, it should be of a self-restoring type.

5.3.6.4 An alarm silencing switch should not be provided unless one of the following criteria applies:

- (1) The silenced position is indicated by a distinctive signal.
- (2) It is a momentary or self-restoring switch.

5.3.6.5 Each electrical carbon monoxide system should have an integral test means to allow the householder to test the system operation.

5.3.7 Combination Systems.

5.3.7.1 Where common wiring is employed for a combination system, the equipment for other than a fire warning signaling system should be permitted to be connected to the common wiring of the system so that short circuits, open circuits, or any other

ground fault in this equipment or interconnection between this equipment and the fire warning system does not interfere with the monitoring for integrity of the fire warning system or prevent alarm or trouble signal transmissions.

5.3.7.2 In a combination system, the operation should be as follows:

- (1) A fire alarm signal should take precedence or be distinctively annunciated over any other signal, even when the non-fire or carbon monoxide signal is initiated first.
- (2) Distinctive alarm signals should be obtained between fire alarms and all other functions.
- (3) The use of a common audible notification appliance should be permitted if distinctive signals are obtained.

5.3.8 Interconnection to Fire Alarm or Combination Control Units.

5.3.8.1 Where carbon monoxide alarms or detectors are interconnected to fire alarm or combination control units, connections should be via supervisory circuits only.

5.3.8.2 Operation of carbon monoxide alarms or detectors should not cause fire alarm or combination control units to activate either protected premises or supervising station fire alarm signals.

5.3.8.3 Where carbon monoxide alarms, detectors, multipurpose detectors, or combination or multiple station alarms or systems are connected to a protected premises fire alarm system, receipt of signals should initiate the signal recommended by 5.3.2 and 5.3.3.

5.3.9 Supervising Station Fire Alarm Systems.

5.3.9.1 Supervising station systems requiring transmission of signals to continually staffed locations providing supervising station services (for example, central station service, proprietary stations, or remote stations) should also comply with the applicable requirements of Chapter 8 of *NFPA 72®*, *National Fire Alarm Code®*.

5.3.9.2 Where carbon monoxide alarms, detectors, multipurpose detectors, or combination or multiple station alarms or systems are connected to supervising station fire alarm systems, receipt of alarm signals should be distinctively indicated as “supervisory signal carbon monoxide” or other non-fire alarm signal designation acceptable to the AHJ.

5.3.9.3 Signals received by the supervising station should be processed by the supervising station personnel in accordance with the following recommendations:

- (1) They should retransmit the supervisory signal to the public fire service communications center.
- (2) They should notify the subscriber by the quickest available method.
- (3) When the signal results from a pre-arranged test, action recommended by 5.3.9.3 (1) and (2) is not necessary.

5.3.10 Low-Power Wireless Systems.

5.3.10.1 Carbon monoxide warning systems utilizing low-power wireless transmission of signals within the protected household should comply with the requirements of *NFPA 72®*, *National Fire Alarm Code®*.

5.3.10.2 Monitoring for placement as required by *NFPA 72®*, *National Fire Alarm Code®*, is not part of this recommendation.

5.4 Installation.

5.4.1 General Provisions.

5.4.1.1 All carbon monoxide alarms or detectors should be installed in accordance with the manufacturer's installation instructions.

5.4.1.2 All carbon monoxide alarms or detectors should be located and mounted so that accidental operation will not be caused by jarring or vibration.

5.4.1.3 All carbon monoxide alarms or detectors should be supported independently of their attachment to wires.

5.4.1.4 All carbon monoxide alarms or detectors should be tested in accordance with the instructions provided by the supplier or installing contractor (*see 5.6.2 and 5.6.3*) to ensure operation after installation.

5.4.1.5 All carbon monoxide alarms or detectors should be restored to their normal mode of operation after each alarm or test.

5.4.1.6 The supplier or installing contractor should provide the owner with the instructions recommended in 5.6.3.

5.4.2 Multiple Station Alarms.

5.4.2.1* Interconnection that causes the other multiple station alarms or the appropriate notification signal of multiple-purpose alarms within an individual family living unit to produce an alarm signal should be permitted.

5.4.2.2 Remote annunciation from single and multiple station alarms should be permitted provided the devices comply with 5.1.2 and 5.3.4.

5.4.2.3 Remote annunciation should be permitted provided the signal is identifiable for the hazard it annunciates.

5.5 Maintenance and Testing.

5.5.1 Maintenance. If batteries are used as a source of energy, they should be replaced in accordance with the instructions provided by the manufacturer.

5.5.2 Testing. Alarms, systems, and all connected notification appliances should be inspected and tested in accordance with the manufacturer's instructions at least once a month.

5.5.3 Control Panels. Homeowners should have every household carbon monoxide detection system with a control panel tested by a qualified service technician at least every three years.

5.6 Markings and Instructions.

5.6.1 General. Carbon monoxide alarms or detectors should be provided with the information specified in 5.6.2 and 5.6.3.

5.6.2 Markings. The following information should be marked on the alarms and detectors and should be provided in the instructions:

- (1) Identification of the sensitivity level at which the unit is designed to sense carbon monoxide
- (2) A statement that indicates that the unit is not suitable as a fire detector
- (3) The name and address of the manufacturer or listee
- (4) The model number
- (5) A mark or certification that the unit has been listed by a nationally recognized testing laboratory
- (6) An electrical rating (if applicable)
- (7) An explanation of signal indicators

(8) A warning that carbon monoxide is odorless, colorless, and tasteless

(9) The proper emergency actions to be taken

(10) A manufacturing date or date code

(11) A recommended replacement date

5.6.3 Instructions. The following information should be included in the printed instructions provided with carbon monoxide alarms and detectors:

- (1) Installation instructions
- (2) Operating instructions
- (3) Testing instructions
- (4) Maintenance instructions
- (5) Replacement and service instructions
- (6) A statement indicating that smoke might not be present during a carbon monoxide alarm condition
- (7)*Printed information on the actions that should be taken in case of an alarm
- (8) Minimum and recommended distances from fuel-burning appliances

Annex A Explanatory Material

Annex A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 This document does not attempt to cover all equipment, methods, and requirements that might be necessary or advantageous for the protection of lives from carbon monoxide exposure.

The effects of exposure to carbon monoxide vary significantly among different people. Infants, pregnant women, and people with physical conditions that limit their body's ability to use oxygen can be affected by low concentrations of carbon monoxide. These conditions include, but are not limited to, emphysema, asthma, and heart disease, all of which are usually indicated by a shortness of breath upon mild exercise.

People in need of warning about low levels of carbon monoxide should explore the use of specially calibrated units or other alternatives.

A.1.1.2 See NFPA 501C, *Standard on Recreational Vehicles*, for equipment for use in recreational vehicles. "Family living unit" is not intended to include hotel or motel rooms or similar occupancies unless they have fuel-burning appliances.

A.1.2.1 Carbon monoxide alarms and detectors are intended to alarm at carbon monoxide levels below those that are known to cause a loss of ability to react to the dangers of carbon monoxide. Refer also to Table B.1(a), Table B.1(b), and Figure B.1.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Family Living Unit. This definition of family living unit is meant to cover living areas only and not common-use areas in multifamily dwellings such as corridors, lobbies, or basements.

A.3.3.5 Fuel-Burning Appliance. Fuel-burning appliances include, but are not limited to, devices used for cooking, heating, lighting, or decorative purposes. Examples are wood stoves, portable space heaters, ranges, furnaces, water heaters, clothes dryers, gas refrigerators, and gas lamps.

A.3.3.9 Separate Sleeping Area. Bedrooms or sleeping rooms separated by other use areas, such as kitchens or living rooms, but not bathrooms, are considered as separate sleeping areas for the purposes of this recommended practice.

A.5.1.1 Experience has shown that hazardous concentrations of carbon monoxide can accumulate in a residence, generally from improperly operating heating appliances, insufficient make-up air into the residence or space, or blocked chimneys or vents. However, there are many other potential sources of carbon monoxide within a home, including the following:

- (1) Malfunctioning fossil fuel appliances
- (2) Wood stoves
- (3) Fireplaces
- (4) Idling automobiles in attached garages
- (5) Portable equipment such as gasoline-powered lawn and garden equipment
- (6) Barbecues

Carbon monoxide is odorless, tasteless, and colorless; therefore, its presence is undetectable by smell, taste, or sight. Carbon monoxide alarms meeting the requirements of UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Detectors*, and installed in accordance with this recommended practice should provide a significant level of protection against fatal carbon monoxide exposure.

The installation of additional carbon monoxide alarms could result in a higher degree of protection. Adding alarms to rooms where fuel burning appliances are located could provide earlier warning of a carbon monoxide hazard caused by those sources. Additional alarms located in a room normally closed off from the recommended alarms could increase the escape time, since the carbon monoxide concentration needed to force the carbon

monoxide out of the closed room to the alarm is not necessary. As a consequence, it is recommended that the installation of additional carbon monoxide alarms be considered.

Carbon monoxide alarms or detectors are not substitutes for proper maintenance, inspection, and testing of fuel burning equipment. Fuel burning equipment and appliances should be used, maintained, tested, and inspected according to the manufacturers' instructions.

A.5.1.1.1 At times, depending on conditions, the audibility of notification appliances could be seriously impaired when occupants are in the bedroom area. For instance, there might be a noisy window air conditioner or room humidifier generating an ambient noise level of 55 dBA or higher. The detection device alarms need to penetrate through the closed doors and be heard over the bedroom's noise levels with sufficient intensity to awaken sleeping occupants therein. Test data indicate that ratings of 85 dBA at 3 m (10 ft) and installed outside the bedrooms can produce about 15 dBA over ambient noise levels of 55 dBA in the bedrooms. This sound pressure is likely to be sufficient to awaken the average sleeping person.

Alarms or detectors located remote from the bedroom area might not be loud enough to awaken the average person. In such cases, it is recommended that units be interconnected in such a way that the operation of the remotely located detector or alarm causes an alarm of sufficient intensity to penetrate the bedrooms. The interconnection can be accomplished by the following:

- (1) Installation of a system
- (2) Wiring together of multiple-station alarms
- (3) Use of line carrier or radio frequency transmitters/receivers
- (4) Adding supplemental notification appliances

A.5.4.2.1 Carbon monoxide alarms or detectors could be susceptible to unwanted alarm signals triggered by vapors from petroleum, alcohols, or household aerosols. An alarm for such a condition might be anticipated and tolerated by the occupant of a family living unit through routine living experience. An alarm would not be acceptable if it also triggered detectors in other family living units or resulted in an alarm of detectors located in common-use areas. Unwanted alarms can occur, and inspection authorities should be aware of the ramifications that could result if the coverage is extended beyond the limits of a single family living unit.

A.5.6.3(7) Actions that should be considered include opening of windows and doors and evacuation. Also, the printed information should provide examples of organizations to be contacted for assistance.

Annex B Dangers of Carbon Monoxide

This annex is not a part of the recommendations of this NFPA document but is included for informational purposes only.

B.1 Carbon Monoxide. Carbon monoxide is an odorless, tasteless, colorless gas produced by incomplete combustion. Solid, liquid, or gaseous fuels can each, under certain conditions, produce lethal concentrations in the home. (See Table B.1(a), Table B.1(b), and Figure B.1.)

The dangers of carbon monoxide exposure depend on a number of variables, such as the occupant's health, activity level, time of exposure, and initial carboxyhemoglobin (COHb) level. Due to these variables, Table B.1(a), Table B.1(b), and Figure B.1 are to be used as general guidelines and might not appear quantitatively consistent.

The following equation for determining the estimated percent of COHb in the blood is from “A proposal for evaluating human exposure to carbon monoxide contamination in military vehicles” by Steinberg and Nielson in the March 1977 publication AMCMS Code 672716.H700011 and “Considerations for the physiological variables that determine the blood carboxyhemoglobin concentration in man” by Coburn, Forster, and Kane in Volume 1965-44 of the *Journal of Clinical Investigation*:

$$\%COHb_t = \%COHb_0 \left[e^{-(t/2398B)} \right] + 218 \left[1 - e^{-(t/2398B)} \right] \times \left(0.0003 + \frac{\text{ppmCO}}{1316} \right)$$

where:

$\%COHb_t$ = percentage of COHb at time t

$\%COHb_0$ = percentage of COHb in the blood at time 0

t = time in minutes

B = 0.0404 (work effort)

Table B.1(a) Symptoms of Carbon Monoxide Exposure Based on Concentration

Concentration (ppm)	Symptoms
50	No adverse effects with 8 hours of exposure
200	Mild headache after 2–3 hours of exposure
400	Headache and nausea after 1–2 hours of exposure
800	Headache, nausea, and dizziness after 45 minutes of exposure; collapse and unconsciousness after 2 hours of exposure
1,000	Loss of consciousness after 1 hour of exposure
1,600	Headache, nausea, and dizziness after 20 minutes of exposure
3,200	Headache, nausea, and dizziness after 5–10 minutes of exposure; collapse and unconsciousness after 30 minutes of exposure
6,400	Headache and dizziness after 1–2 minutes of exposure; unconsciousness and danger of death after 10–15 minutes of exposure
12,800 (1.28% by volume)	Immediate physiological effects; unconsciousness and danger of death after 1–3 minutes of exposure

CAUTION: The values in this table are approximate values for healthy adults. Children, the elderly, and persons with pre-existing physical conditions might be more susceptible to the effects of carbon monoxide exposure. Continued exposure after unconsciousness can cause death.

Table B.1(b) Symptoms of Carbon Monoxide Exposure Based on Percentage of Carboxyhemoglobin in Blood

% Carboxyhemoglobin (COHb) in Blood	Related Health Effects
80	Death ¹
60	Loss of consciousness; death if exposure continues ¹
40	Confusion; collapse on exercise ¹
30	Headache; fatigue; impaired judgement ¹
7–20	Statistically significant decreased maximal oxygen consumption during strenuous exercise in healthy young men ²
5–17	Statistically significant diminution of visual perception, manual dexterity, ability to learn, or performance in complex sensorimotor tasks (such as driving) ²
5–5.5	Statistically significant decreased maximal oxygen consumption and exercise time during strenuous exercise in young healthy men ²
Below 5	No statistically significant vigilance decrements after exposure to CO ²
2.9–4.5	Statistically significant decreased exercise capacity (i.e., shortened duration of exercise before onset of pain) in patients with angina pectoris and increased duration of angina attacks ²
2–3.4.3	Statistically significant decreased (about 3–7%) work time to exhaustion in exercising healthy men ²

Source: ¹U.S. EPA (1979); ²U.S. EPA (1985)

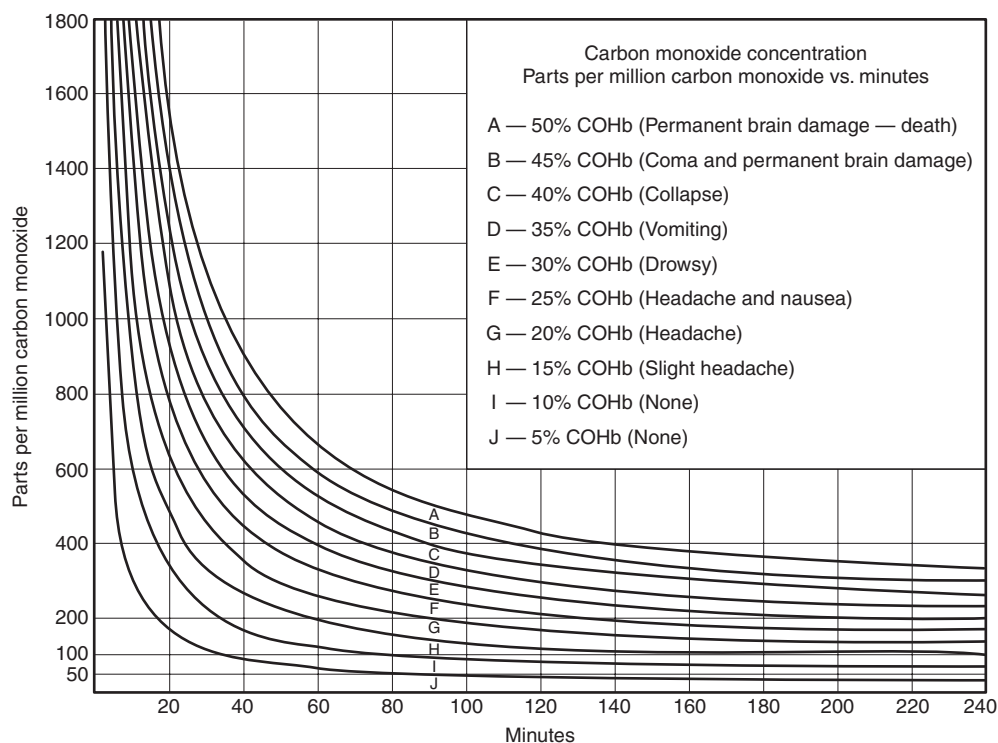


FIGURE B.1 Carbon Monoxide Concentration (ppm CO) Versus Time (Minutes).

Annex C Informational References

C.1 Referenced Publications. The following documents or portions thereof are referenced within this recommended practice for informational purposes only and are thus not part of the recommendations of this document unless also listed in Chapter 2.

C.1.1 NFPA Publication. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101. NFPA 501C, *Standard on Recreational Vehicles*, 1996 edition.

C.1.2 Other Publications.

C.1.2.1 UL Publication. Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Detectors*, October 29, 1996.

C.1.2.2 Steinberg, Nielson, "A proposal for evaluating human exposure to carbon monoxide contamination in military vehicles," AMCMS Code 672716.H700011, March 1977.

C.1.2.3 Coburn, R. F., Forster, R. E., and Kane, P. G., "Considerations for the physiological variables that determine the blood carboxyhemoglobin concentration in man," *Journal of Clinical Investigation*, 1965, 44, 1899-1910.

C.2 Informational References. (Reserved)

C.3 References for Extracts. The following documents are listed here to provide reference information, including title and edition, for extracts given throughout this recommended practice as indicated by a reference in brackets [] following a section or paragraph. These documents are not a part of the recommendations of this document unless also listed in Chapter 2 for other reasons.

NFPA 72®, *National Fire Alarm Code*®, 2002 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, 2003 edition.

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