

# CARBON MONOXIDE

6604

CO                      MW: 28.00                      CAS: 630-08-0  
 RTECS: FG3500000

**METHOD:** 6604, Issue 1

**EVALUATION:** FULL

**Issue 1:** 15 May 1996

**OSHA :** 50 ppm

**NIOSH:** 35 ppm; C 200 ppm

**ACGIH:** 25 ppm

(1 ppm = 1.14 mg/m<sup>3</sup>)

**PROPERTIES:** gas; BP -192 °C; MP -207 °C; vapor density (air=1) 0.967; flammable (explosive) limits in air 12.5 to 74.2%

**SYNONYMS:** monoxide; carbon oxide; carbonic oxide; flue gas

SAMPLING		MEASUREMENT	
<b>SAMPLER:</b>	PORTABLE DIRECT-READING CO MONITOR	<b>TECHNIQUE:</b>	ELECTROCHEMICAL SENSOR
<b>VOL-MIN:</b>	instrument dependent	<b>ANALYTE:</b>	carbon monoxide (CO)
<b>-MAX:</b>	none	<b>CALIBRATION:</b>	
<b>SHIPMENT:</b>	routine shipment of instrumentation	<b>- ZERO:</b>	CO-free air
<b>SAMPLE STABILITY:</b>	at least 7 days @ 25 °C [1] (aluminized air bags)	<b>-SPAN:</b>	standard cylinders of span gas in the desired range
<b>BLANKS:</b>	fresh air or compressed CO-free air from cylinder	<b>RANGE:</b>	0 to 200 ppm
<b>ACCURACY</b>		<b>ESTIMATED LOD:</b>	1 ppm
<b>RANGE STUDIED:</b>	0 to 200 ppm	<b>PRECISION (S<sub>r</sub>):</b>	0.035 @ 20 ppm 0.012 @ 50 ppm 0.008 @ 100 ppm [2]
<b>BIAS:</b>	- 1.7% [2]		
<b>OVERALL PRECISION (S<sub>rr</sub>):</b>	0.022 [2]		
<b>ACCURACY:</b>	± 6.0%		

**APPLICABILITY:** Portable, direct-reading carbon monoxide monitors are applicable to any work environment for personal or area monitoring.

**INTERFERENCES:** Several gaseous pollutants (e.g., NO<sub>2</sub>, SO<sub>2</sub>) may cause an interference at levels over 5 ppm. If these or other pollutants are known or suspected to be present, use a monitor with a chemical interference scrubber over the sensor. Unknown pollutants may require further experimentation to determine their effect on the sensor. As tested, SO<sub>2</sub> (5 ppm), CO<sub>2</sub> (5000 ppm), methylene chloride (500 ppm), diesel fuel (6 µL/L, about 0.3 ppm benzene), and gasoline vapor (1 µL/L, about 1 ppm benzene) had no impact on most monitor readings [2]. Some monitors are equipped with a chemical interference scrubber while others offer this as an option.

**OTHER METHODS:** Bag samples may be collected in aluminized bags (2-L or larger) and analyzed later by placing the calibration cap over the sensor and pumping the sample across the sensor at a nominal rate of 0.250 L/min with a personal sampling pump.

**REAGENTS:**

1. CO\*calibrationgas, 20 to 50 ppm, compressed gas cylinder, appropriate pressure regulator, and other items as recommended by manufacturer for field check of monitor response.

\* See SPECIAL PRECAUTIONS

**EQUIPMENT:**

1. Carbon monoxide monitor: Envirocheck I single sensor CO Monitor (Quest Technologies); CO262 or STX70 (Industrial Scientific); MiniCO (MSA); or other electrochemical CO monitor with equivalent performance specifications.
2. Personal sampling pump, 0.250 L/min, with inlet and outlet, used for bag filling and sample analysis when off-site analysis is needed.
3. Air bags, aluminized, 2-L, or other appropriate sizes (optional).
4. Replacementbatteries or battery recharger, as appropriate for monitor.

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**SPECIAL PRECAUTIONS:** Carbon monoxide is a highly flammable, dangerous fire and explosive risk, and is toxic by inhalation. Shipments of compressed calibration gases must comply with 49 CFR 1992 regulations.

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**SAMPLING AND MEASUREMENT:**

1. Zero monitor with CO-free air at the same temperature and relative humidity as the work environment, if possible.  
NOTE: Monitors are more sensitive to temperature variations than to humidity variations. Most monitors have temperature compensating circuitry
2. For personal monitoring, locate the monitor as near the worker's breathing zone as possible.
3. For area monitoring, locate monitor in an area with good air circulation about 60 to 70 inches above the floor.  
NOTE: Make sure the sensor is not obstructed in either application.

**CALIBRATION AND QUALITY CONTROL:**

4. Calibrate with a standard calibration mixture of CO in air from a pressurized cylinder at the CO level recommended by the monitor manufacturer (Normally, 20 to 50 ppm CO). The monitshould be calibrated at the temperature and relative humidity as near as possible to that of the work environment in which it will be used.
5. Check the calibration daily and recalibrate whenever the monitor reading varies from the span gas by 5% or more, or as the manufacturer recommends.

**CALCULATIONS:**

6. Read concentration directly from the monitor display.

Some monitors (data logger models) will maintain a continuous record of the data as it is accumulated and will calculate the Average, TWA, Peak, etc. concentrations. These data may be read from the display at any time. Some monitors will also store this information for downloading to a computer or printer at the end of the monitoring period. Other monitors only display the current reading, requiring the operator to manually record the data. All monitor models are equipped with alarms that will warn the user (audibly, visually or both) whenever the concentration of CO exceeds the preset level of the alarm. Many are equipped with two-level alarms [3].

**EVALUATION OF METHOD:**

The performance of six direct-reading carbon monoxide monitors was evaluated over a period of 12 months

at CO concentrations up to 200 ppm and a range of ambient temperatures and relative humidities. Most of the tests were conducted at or near the PEL. For mean recovery studies, six different monitors were used and readings were taken approximately 1 h apart. Recovery at 20 ppm was 105% (n = 42); at 50 ppm, 99.6% (n = 36); and at 100 ppm, 99.9% (n = 30). Thus, the overall mean bias was calculated at - 1.7%. The precision ( $\bar{S}_r$ ) at 20 ppm was 0.035 (35 readings from 5 monitors over a 7-h period). At 50 ppm,  $\bar{S}_r$  was 0.012 (30 readings from 5 monitors over a 6-h period), and at 100 ppm,  $\bar{S}_r$  was 0.008 (36 readings from 6 monitors over a 6-h period). Tests also were conducted to determine response time, zero and span drift, alarm decibel level, battery life, life of the sensors, as well as the effects of selected interferences (gases, vapors, and RF) and the effects of handling and transporting to remote sites.

#### REFERENCES:

- [1] NIOSH [1977]. Backup data report no. S340, prepared under NIOSH Contract No. 210-76-0123.
- [2] Woodfin WJ, Woebkenberg ML [in preparation]. An evaluation of portable direct-reading carbon monoxide monitors.
- [3] Ashley K [1994]. Electroanalytical applications in occupational and environmental health. *Electroanalysis* 6:805-820.

#### METHOD WRITTEN BY:

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