



Designation: D 3162 – 94 (Reapproved 2000)^{ε1}

Standard Test Method for Carbon Monoxide in the Atmosphere (Continuous Measurement by Nondispersive Infrared Spectrometry)¹

This standard is issued under the fixed designation D 3162; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

^{ε1} NOTE—Editorial corrections were made throughout in September 2000.

1. Scope

1.1 This test method is applicable to the determination of the carbon monoxide (CO) concentration of the atmosphere between 0.6 mg/m³ (0.5 ppm(v)) and 115 mg/m³ (100 ppm(v)). The measuring principle is based on the absorption of infrared radiation by CO in the 4.7 μm region (1).²

1.2 The test method has a limit of detection of about 0.6 mg/m³ (0.5 ppm(v)) carbon monoxide in air.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. See Section 9 for additional precautions.*

2. Referenced Documents

2.1 ASTM Standards:

- D 1356 Terminology Relating to Sampling and Analysis of Atmospheres³
- D 1357 Practice for Planning the Sampling of the Ambient Atmosphere³
- D 1914 Practice for Conversion Units and Factors Relating to Sampling and Analysis of Atmospheres³
- D 3249 Practice for General Ambient Air Analyzer Procedures³
- D 3631 Test Methods for Measuring Surface Atmospheric Pressure³
- E 1 Specification for ASTM Thermometers⁴
- E 180 Practice for Determining the Precision of ASTM

¹ This test method is under the jurisdiction of ASTM Committee D22 on Sampling and Analysis of Atmospheres, and is the direct responsibility of Subcommittee D 22.03 on Ambient Atmospheres and Source Emissions.

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² The boldface numbers in parentheses refer to the list of references at the end of the standard.

³ Annual Book of ASTM Standards, Vol 11.03.

⁴ Annual Book of ASTM Standards, Vol 14.03.

Methods for Analysis and Testing of Industrial Chemicals⁵

3. Terminology

3.1 Definitions:

3.1.1 For definitions of terms used in this test method, refer to Terminology D 1356 and Practice D 3249.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *fall time*—the time interval between initial response and 90 % of final response after a step decrease in input concentrations.

4. Summary of Test Method

4.1 An atmospheric sample is introduced into a sample conditioning system and then into a nondispersive infrared spectrometer (NDIR). The spectrometer measures the absorption by CO at 4.7 μm using two parallel infrared beams through a sample and a reference cell and a selective detector. The detector signal is conducted to an amplifier control section, and the analyzer output measured on a meter and recording system (2).

4.1.1 Some instruments use gas filter correlation to compare the IR absorption spectrum between the measured gas and other gases present in the gas being sampled, in a single sample cell. These instruments utilize a concentrated sample of CO as a filter for the IR transmitted through the sample cell to produce a beam that cannot be further attenuated by the CO in the sample, and thus produces the reference beam. The broadband radiation that passes through the sample cell and the CO filter is filtered again by a narrow-band-pass filter that allows only the CO-sensitive portion of the band to pass to the detector. The removal of wavelengths sensitive to other gases reduces interferences.

4.2 The concentration of CO in the sample is determined from a calibration curve prepared using standard calibration gases.

⁵ Annual Book of ASTM Standards, Vol 15.05.

5. Significance and Use

5.1 Determination of carbon monoxide is essential to evaluation of many air pollution complexes. This test method derives significance from providing such determination.

5.2 Carbon monoxide is formed in the process of incomplete combustion of hydrocarbon fuels, and is a constituent of the exhaust of gasoline engines. The Environmental Protection Agency (EPA) has set primary and secondary air quality standards for CO that are designed to protect the public health and welfare (3, 4).

5.3 This test method is suitable for measurements appropriate for the purposes noted in 5.1 and 5.2.

6. Interferences

6.1 Degree of interference varies among individual instruments. Consult manufacturer's specifications for the particular analyzer to determine whether interferences render the instrument unsuitable for the proposed use.

6.2 The primary interferent is water vapor. With no correction, the error may be as high as 11 mg CO/m³ map edit n (10 ppm(v)) (5).

6.2.1 Water vapor interference can be minimized by using one of the following steps:

6.2.1.1 Passing the air sample through silica gel or similar drying agent.

6.2.1.2 Maintaining constant humidity in the sample and calibration gases by refrigeration.

6.2.1.3 Saturating the air sample and calibration gases to maintain constant humidity.

6.2.1.4 Using narrow-band optical filters in combination with some of the above measures.

6.2.1.5 Where sample is dried or humidified a volume correction may be necessary.

6.2.1.6 Gas correlation spectrometers minimize interferences and use a narrow-band-pass filter to ensure measuring only the CO-sensitive IR wavelengths.

6.3 Interference may be caused by carbon dioxide (CO₂). The effect of CO₂ interference at concentrations normally present in ambient air is minimal; that is, 1350 mg (750 ppm(v)) CO₂/m³ may give a response equivalent to 0.6 mg CO/m³ (0.5 ppm(v)) (5).

6.4 Hydrocarbons at concentrations normally found in the ambient air do not ordinarily interfere; that is, 325 mg methane/m³ (500 ppm(v)) may give a response equivalent to 0.6 mg CO/m³ (0.5 ppm(v)) (5).

7. Apparatus

7.1 *NDIR Carbon Monoxide in Air Analyzer*, complete with voltage transformer, analyzer section, amplifier/control section, meter, and recording system. Analyzer must meet or exceed performance specifications described in Annex A1.

7.2 *Sample Conditioning System*, consisting of pump, flow control valve, pressure relief valve, flowmeter, filter, and moisture control.

7.3 A typical sampling and analyzer system is described in Fig. 1.

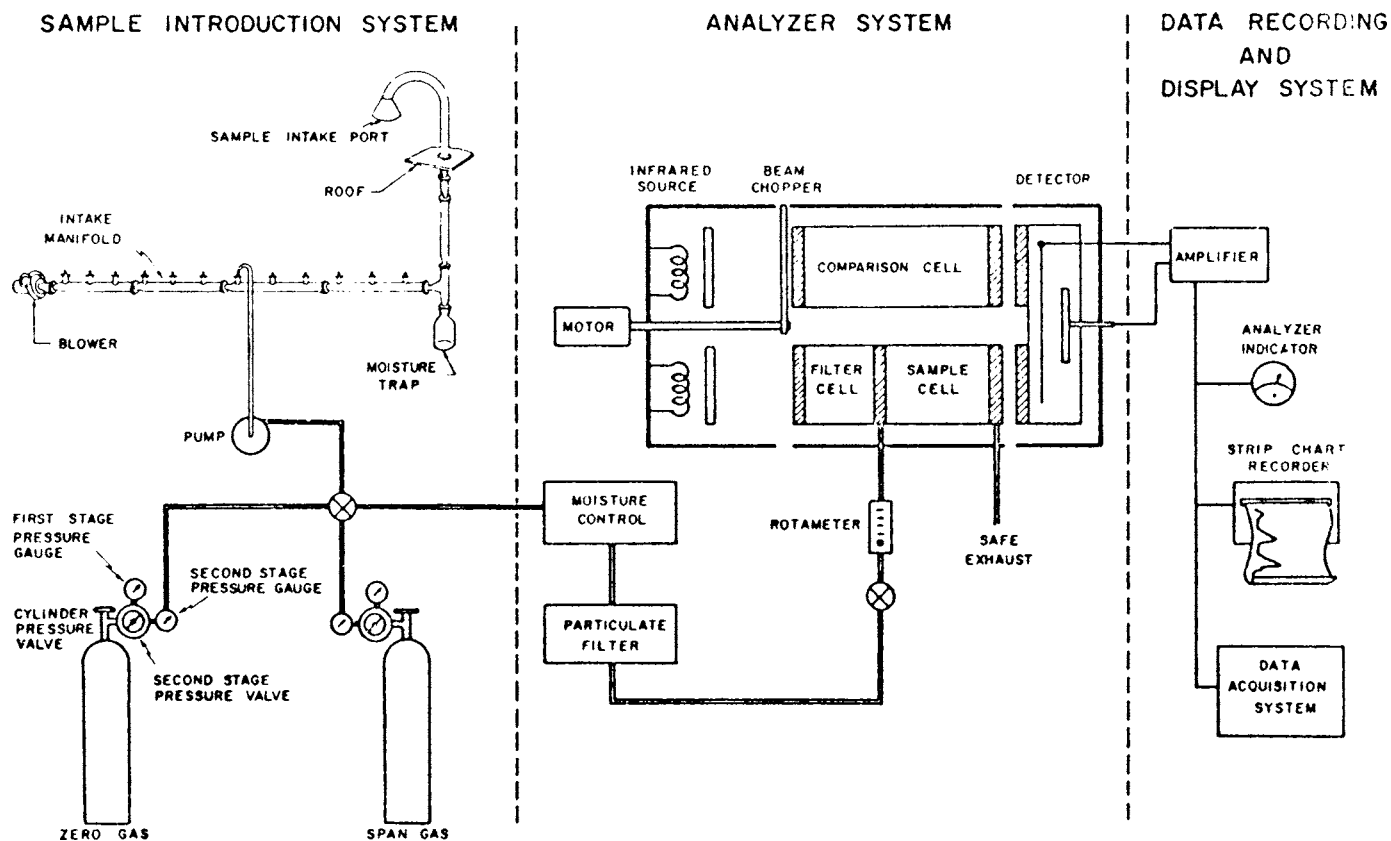


FIG. 1 Carbon Monoxide Monitoring System Flow Chart