

**Standard**

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**Performance Requirements  
for Carbon Monoxide  
Detection Instruments  
(50 - 1000 ppm Full Scale)**



ISA-S92.02.01-1998, Part I Performance Requirements for Carbon Monoxide Detection  
Instruments (50 - 1000 ppm Full Scale)

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## Preface

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This preface, as well as all footnotes and annexes, is included for informational purposes and is not part of ISA-S92.02.01, Part I.

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**CAUTION: CARBON MONOXIDE IS A TOXIC GAS. EXPOSURE MAY BE HAZARDOUS TO HEALTH AND LIFE.**

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## **1 Scope**

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**1.1** This Standard covers the details of construction, performance, and testing of portable, mobile, and stationary electrical instruments. These instruments may be used to monitor for the presence of carbon monoxide gas concentrations in air. Parts of the instruments may be installed or operated in hazardous (classified) locations.

**1.2** This Standard applies to mains-connected instruments rated at 250 V nominal or less, and to portable, mobile, and stationary battery-powered instruments.

**1.3** This Standard applies to instruments suitable for use in an ambient temperature range of at least -10°C to 50°C (14°F to 122°F).

**1.4** This Standard addresses carbon monoxide gas detection instruments intended to provide a warning of the presence of potential hazards in the concentration ranges up to 1000 ppm. Hereafter, the term "gas detection instrument" refers to a CO gas detection instrument.

**1.5** This Standard does *not* address laboratory- or scientific-type carbon monoxide detection instruments used for analysis or measurement in process control and process monitoring applications, instruments intended for residential purposes, or instruments with full-scale gas concentration ranges less than 50 ppm or greater than 1000 ppm.

**NOTE** – The user should specify instrumentation that will provide a higher level of accuracy than the minimum tolerances of this Standard if required by the application risk.

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## **2 Purpose**

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**2.1** Part I of this Standard provides minimum performance requirements of electrical instruments for the detection of carbon monoxide gas (CO), in order to enhance the safety of personnel.

**2.2** Part II of this Standard establishes user criteria for the installation, operation, and maintenance of carbon monoxide gas detection instruments.

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## 3 Definitions

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For the purposes of this Standard, the following definitions apply:

**3.1 alarm:** An audible, visual, or physical presentation designed to alert the instrument user that a specific level of carbon monoxide concentration has been reached or exceeded.

**3.2 alarm-only instrument:** An instrument that provides alarm(s), but does not have an integral display device indicating carbon monoxide concentration levels.

**3.3 alarm setpoint:** The selected gas concentration level(s) at which an alarm is activated.

**3.4 ambient air:** Air to which the sensing element is normally exposed.

**3.5 calibration:** The procedure to adjust the instrument for proper response (e.g. — zero level, span, alarm, and range).

**3.6 calibration gas:** The known concentration(s) of carbon monoxide gas used to set the instrument span or alarm level(s).

**3.7 carbon monoxide:** Interchangeable within this document for "CO" or "carbon monoxide gas."

**3.8 clean air:** Air that is free of any substance that will adversely affect the operation of or cause a response of the instrument.

**3.9 consumables:** Materials or components that are depleted or require periodic replacement through normal use of the instrument.

**3.10 control unit:** The portion of a multi-part gas detection instrument that is not directly responsive to the gas, but which responds to the electrical signal obtained from one or more detector heads to produce an indication, alarm, or other output function.

**3.11 detector head:** The gas-responsive portion of a gas detection instrument located in the area where sensing the presence of gas is desired. Its location may be integral to or remote from its control unit.

**NOTE** – The detector head may incorporate the gas-sensing element and additional circuitry such as signal processing or amplifying components or circuits.

**3.12 diffusion:** A process by which the CO atmosphere being monitored is transported by natural random molecular movement to and from the gas-sensing element.

**3.13 gas detection instrument:** An assembly of electrical, mechanical, and (possibly) chemical components that senses and responds to the presence of gas in air mixtures.

**NOTE** – For convenience, the term "instrument" is used as an abbreviation for "gas detection instrument" within this Standard.

**3.14 gas-sensing element:** The particular subassembly or element in the gas detection instrument that, in the presence of a gas, produces a change in its electrical, chemical, or physical characteristics.

**3.15 IDLH (Immediately Dangerous to Life and Health):** The maximum concentrations from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing (e.g., severe eye irritation) or irreversible health effects.

**3.16 mobile instrument:** A continuous-monitoring instrument mounted on a vehicle such as, but not limited to, a mining machine or industrial truck.

**3.17 nominal voltage:** The voltage given by manufacturers as the recommended operating voltage of their gas detection equipment. If a range (versus a specific voltage) is given, the nominal voltage shall be considered as the midpoint of the range, unless otherwise specified.

**3.18 PELs (Permissible Exposure Limits):** Time-weighted average (TWA) concentrations that must not be exceeded during any 8-hour work shift of a 40-hour workweek, as defined by OSHA.

**3.19 portable instrument:** An instrument that is self-contained, battery-operated, transportable, and can be carried by an individual.

**NOTE** – This type of instrument is intended to operate continuously for 8 hours or more.

**3.20 range:** The values of concentrations of carbon monoxide over which accuracy is ensured by calibration.

**3.21 sample-draw:** A method to cause deliberate flow of the atmosphere being monitored to a gas-sensing element.

**3.22 signal-processing detector head:** An instrument intended to be incorporated with separate signal processing, data acquisition, central monitoring, or other similar systems in which the instrument provides a conditioned electronic signal or output indication to systems of the aforementioned type that typically process information from various locations and sources including, but not limited to, gas detection instruments.

**3.23 span:** The algebraic difference between the upper and lower values of a range.

**3.24 stationary instrument:** A gas detection instrument intended for permanent installation in a fixed location.

**3.25 STEL (Short Term Exposure Limit):** A 15-minute TWA exposure that should not be exceeded at any time during a workday, even if the 8-hour TWA is within the Threshold Limit Value-Time-Weighted Average (TLV-TWA). Exposures above the TLV-TWA up to the STEL should not be longer than 15 minutes and should not occur more than four times per day. There

should be at least 60 minutes between successive exposures in this range. An average period other than 15 minutes may be recommended when warranted by observed biological effects.

**3.26 test gas:** Carbon monoxide diluted with clean air or inert gas and to a known concentration within 5 percent of nominal concentration or 2 ppm, whichever is greater.

**3.27 TLV-TWA (Threshold Limit Value-Time-Weighted Average):** The time-weighted average concentration for a normal 8-hour workday in a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

**3.28 trouble signal:** A signal (contact transfer or signal [visible or audible]) that alerts an instrument user of abnormal conditions such as input power failure, an open circuit breaker, a blown fuse, loss of continuity to the detector head, defective gas-sensing element, or significant downscale indication.

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## 4 General requirements

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**4.1** Gas detection instruments shall meet the applicable electrical and electronic measuring instrument requirements of ANSI/ISA-S82.01. [See Annex A.](#)

**4.2** Any portion of a stationary gas detection instrument and all portable instruments that are intended for installation or use in a hazardous (classified) location shall be suitable for use in the location. Refer to the National Electrical Code®, NFPA 70, Articles 500-505.

**4.3** All carbon monoxide gas detection instruments shall meet the minimum construction and test requirements contained in this Standard. If the manufacturer makes performance claims that exceed these requirements, all such claims shall be verified to the satisfaction of the testing laboratory.

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## 5 Construction

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### 5.1 General

**5.1.1** Gas detection instruments, their components, and remote detector heads specifically intended for use in the presence of corrosive vapors or gases shall be constructed of materials resistant to or protected against corrosion.

**5.1.2** Instruments of the sample-draw type shall include the necessary sample-pumping mechanisms.

### 5.2 Meters, indicators, and outputs

**5.2.1** Instruments having an integral meter to indicate gas concentrations shall employ a meter having sufficient resolution to permit measurement with the precision required for performing the tests referenced herein.

**5.2.2** Nonlinear scales or indicators are permissible when prominently and clearly noted in the instruction manual.

**5.2.3** Gas detection instruments shall provide a means to indicate to the user that a gas concentration in excess of the range of the instrument has been detected.

**5.2.4** When auxiliary outputs (e.g. — 4mA to 20 mA) from the gas detection instrument are provided, their malfunction shall not adversely affect instrument alarm functions.

**5.2.5** Devices (such as switches) that disable alarm or trouble outputs or signals are acceptable if the following criteria are met:

- a) Alarm or trouble outputs or signals are automatically enabled when the device is returned to the operating (normal) mode.
- b) A distinctive visual or audible indication, or both, and a distinctive output signal are provided with the device in the disable (bypass) mode.
- c) Local (i.e., at the instrument) visual alarm indications are not disabled.

**EXCEPTION:** Indicators may be disabled when the instrument is in calibration mode.

**5.2.6** Instruments of the sample-draw type shall incorporate a device to indicate either adequate or inadequate flow. In portable instruments, the flow device may be omitted provided that the instruction manual contains detailed instructions as required by [6.2.1](#).

### 5.3 Alarm/output function(s) (where provided)

**5.3.1** All stand-alone gas detection instruments shall include alarm functions. Signal-processing heads, approvable under this Standard, are designed as components of a data acquisition, central monitoring, or similar system in which the alarm and malfunction actions are inherently part of the system, and hence alarm functions are not separately required as part of the sensing head.

**5.3.2** The instrument shall employ an integral alarm device or provide outputs intended to indicate a gas concentration above a specific level, or both. Alarms shall be of the latching type, requiring a deliberate manual action to reset.

**5.3.3** The latching requirement may be omitted, or a defeating option permitted, if a clear and prominent statement in the instruction manual recommends that the instrument be connected to an auxiliary system that accomplishes the same purpose as latching.

**EXCEPTION:** The latching requirement may be omitted on personal gas detection instruments designed to be carried at all times when in use.

**5.3.4** All instruments shall have at least one alarm function preset to current OSHA PEL or below. This alarm shall not be adjustable above either the ceiling (if available) or 50 percent of the IDLH, whichever is lower.

**5.3.5** All portable gas detection instruments shall be provided with a distinguishable alarm indicating low-battery condition. This alarm shall operate for a minimum of 5 minutes, during which time no erratic readings or false alarms are permitted.

### 5.4 Trouble signals

**5.4.1** Where applicable, all gas detection instruments shall provide for a signal or contact transfer to produce a trouble signal in the event of

- a) input power failure to the instrument;
- b) opening of circuit protection device;
- c) loss of continuity in any one or more electrical conductors or other links to any remote detector head; or
- d) downscale indication below zero equivalent to 10 percent of the range in use or 10 ppm, whichever is less.

Such signal or contact transfer shall be independent of other alarms, shutdown signals, and contact transfer.

**NOTE** – It is desirable to provide a trouble signal for a missing sensor or for a gas-sensing element or associated circuit failure.

**5.4.2** Stationary and mobile sample-draw gas detection instruments shall be provided with flow-proving devices that produce a trouble signal in the form of a contact transfer or signal transfer in the event of flow outside the manufacturer's stated flow rate range.

## 5.5 Controls and adjustments

**5.5.1** All gas detection instruments shall be provided with means for facilitating calibration checks and adjustments as required.

**5.5.2** Calibration, zero, and alarm(s) settings shall be designed to minimize the possibility of unauthorized or accidental readjustment, and shall require a key, code, or tool for adjustment.

## 5.6 Consumables

**5.6.1** Instruments powered by integral batteries shall be capable of continuous operations at a temperature of -10°C (14°F) for a period of at least 8 hours, including 15 minutes of maximum load (i.e., continuous alarm, lights, etc.) without replacement or recharge of batteries.

**5.6.2** Portable and mobile instruments requiring consumables shall be capable of operating a minimum of 8 hours without replacement or replenishment of such consumables.

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# 6 Instrument markings and instruction manuals

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## 6.1 Markings on instruments

**6.1.1** The markings required in this clause are in addition to the marking requirements contained in 4.2.

**6.1.2** The markings required by this Standard shall appear in a clearly legible, visible, and permanent manner on each gas detection instrument in the following manner, as applicable:

- a) For portable instruments, the markings shall appear both on the outside surface of the instrument and also on any removable carrying case, if the case obscures the markings required.
- b) For stationary instruments, the marking required shall appear in a location where it will be visible after installation and in direct sight during the routine periodic recalibration and adjustment of alarm setpoint(s).

**6.1.3** All gas detection instruments shall be marked "**CAUTION— READ AND UNDERSTAND INSTRUCTION MANUAL BEFORE OPERATING OR SERVICING.**"

The word "**CAUTION**" of the foregoing shall be in capital letters at least 3 mm (0.12 in.) high. The balance of the wording shall be in capital letters at least 2.5 mm (0.10 in.) high.

**NOTES:**

- 1) For instruments that comprise a control unit and a remote detector head, it is sufficient that the marking appear on the control unit only; however, if routine recalibration can be accomplished entirely by adjustments at the remote detector location(s), this marking shall appear both on the control unit and on the remote detector head.
- 2) For modular control units comprising one or more control modules in a common enclosure or mounting assembly, the marking need not be repeated on each module, but may appear as a single marking on the common portion of the assembly.
- 3) For instruments that lack sufficient space for required markings or for instruments having interchangeable gas-sensing elements, the marking shall be provided on permanent labels or tags that are attached to the instrument by the manufacturer or user.

**6.1.4** If the design or special features of the instrument requires additional markings or changes in marking requirements, the additions or revisions are allowed, but the safety and instructional intent of 6.1 must be met.

**6.1.5** The manufacturer's stated temperature range over which the detector heads will perform within specifications shall appear in a clearly legible, visible, and permanent manner on each detector head. If multiple or interchangeable gas-sensing elements are provided in a common housing, the most restrictive temperature range shall be used.

**6.1.6** The range of detection shall be indicated on the instrument.

## **6.2 Instruction manual**

**6.2.1** Each instrument shall be provided with an instruction manual, furnished by the manufacturer, which shall contain at least the following information:

- a) a list of desensitizing, contaminating, or interfering substances or water vapor concentrations known to the instrument manufacturer, which may adversely affect proper operation of the instrument. (Warning as to effects of oxygen-enriched or oxygen-deficient atmospheres must be included.);

**NOTE** – Recognizing that it is difficult to compile a complete list of all possible desensitizing or contaminating gases or other substances, it is recommended that the manual also include either the generic description of the sensing element or a description of its properties so that the user can evaluate the probable effect of contaminants that are not included in the list.

- b) instructions and recommended frequencies for checking and calibrating: (1) on a routine basis, (2) following exposure to desensitizing or contaminating substances, and (3) following exposure to concentrations causing operation of any alarm;
- c) complete installation and initial start-up instructions;



- d) a list of operating adjustments and instructions for setting these adjustments (e.g. — alarm setpoint, zero, and span adjustments);
- e) details of instrument operational limitations (e.g. — ambient temperature limits for all parts of the instrument, minimum warm-up time, humidity range, voltage range, maximum loop resistance, and minimum wire size for wiring between the control unit and remote detector head(s), need for shielding of wiring, grounding requirements, battery life, accuracy, response times, maximum and minimum storage temperatures, pressure effects and limits, sample-draw lag times, and air velocity limits);
- f) for multi-gas detection instruments, a list of gases for which the instrument has been performance tested;
- g) instructions to clearly indicate the nature and significance of all alarms, trouble signals, and any provisions that may be made for silencing or resetting of these alarms;
- h) instructions for the installation and operation of any accessories provided;
- i) a list of available options;
- j) for instruments of the sample-draw type, detailed instructions to ensure that sample lines are intact and proper flow is established;
- k) for instruments of the sample-draw type, instructions to indicate the minimum and maximum flow rate or range of flow rates, tubing specifications, sample-draw lag times, and materials suitable for transportation lines for proper operation;
- l) for instruments of the sample-draw type, adequate data/information to advise the user of inaccuracies caused by absorption/adsorption of carbon monoxide by sample lines and contaminants;
- m) an operational review to determine possible sources of malfunction and the corrective procedures, including periodic servicing of the instrument;
- n) a listing of consumable and replacement components and the expected life/usage rate and recommendations for storage of each item;
- o) installation instructions, with an emphasis on the gas-sensing element;
- p) minimum and maximum operating voltages for both battery-operated and line-powered instruments;
- q) a listing of recommended batteries for portables by manufacturer and model number (not necessarily all-inclusive);
- r) information concerning effects of externally generated Electromagnetic Interference (EMI) on instrument performance. Likewise, information concerning any EMI generated by the instrument, if such EMI could be detrimental to other nearby instrumentation;
- s) the specific type(s) of calibration gas to be used;
- t) information concerning nonlinear ranges, indicators, and outputs;
- u) relationship between any outputs and carbon monoxide concentrations; and

- v) a recommendation for external alarm latching when non-latching alarms are provided.

**6.2.2** For signal-processing detector heads, the manufacturer shall supply with the instrument a specification that describes the relationship that the gas concentration detected by the instrument has with the corresponding output signal or indication. Such specification shall be detailed to the extent that the accuracy of the output or signal indications can be verified. As a minimum, the manufacturer shall provide data showing the relationship between the output signal or indication of the instrument and gas concentrations corresponding to 20 to 30 percent, 40 to 60 percent, and 70 to 90 percent of each calibration range.

**6.2.3** The design or special nature of the instrument may require additional instruction or special information that is in contradiction of, or in addition to, the requirements of [6.2.1](#) and [6.2.2](#).

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## 7 Performance tests

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### 7.1 General

**7.1.1** The tests described in [7.5 through 7.20](#) are in addition to the requirements specified in Clause 4.

**7.1.2** The instrument to be tested shall be fully representative of instruments intended for commercial production, and the same instrument shall be subjected to all tests applicable to that type of instrument.

**7.1.3** Unwarranted (false) alarms shall be considered failure of the tests.

**7.1.4** In [7.9](#), [7.13](#), [7.14](#), and [7.18](#), the tolerance of the test gas concentrations shall be added to the instrument indications.

### 7.2 Sequence of tests

The sequence of tests shall correspond to the order of these paragraphs.

**EXCEPTION:** The tests described by [7.10 through 7.17](#) may be performed in any order following the test described by [7.9](#), but before the test described by [7.18](#).

### 7.3 Preparation of the instrument

**7.3.1** The instrument selected for testing shall be prepared as if for actual service, including all necessary interconnections and initial adjustments, in accordance with the manufacturer's instruction manual.

**7.3.2** For instruments having remote detector heads, all tests shall be performed with resistance(s) connected in the detector circuits to simulate the maximum line resistance specified by the instrument manufacturer (except where the minimum line resistance offers a more stringent test in the judgment of the testing laboratory).

**7.3.3** For signal-processing detector heads, adequate means for interpreting the output signal shall be provided.

## **7.4 Conditions for test and test area**

**7.4.1** Except as otherwise indicated herein, all tests shall be performed at the nominal system voltage and frequency marked on the equipment (or specified in the instruction manual), or with fresh or fully charged batteries, as applicable.

**7.4.2** Except as otherwise indicated herein, tests may be performed at any temperature in the range of 18°C to 30°C (64°F to 86°F).

**7.4.3** Except as otherwise indicated herein, tests may be performed in ambient air having a relative humidity in the range of 30 to 70 percent. Corrections shall be made for water vapor displacing carbon monoxide.

**7.4.4** Except as otherwise indicated herein, tests are to be performed in relatively still air (velocity not more than 1.0 meter per second [m/s] [3.3 feet per second (f/s)]) other than those currents that may be induced by convection due to the natural heating of the equipment under test or caused by air-moving devices that are part of the equipment under test.

**7.4.5** For purposes of the tests in [7.7 through 7.20](#), where reference is made to exposing the detector head to specified gas mixtures or to other specified conditions, all normally attached diffusion devices or protective mechanical parts shall remain attached.

**7.4.6** For instruments intended to be used with more than one remote detector head, only one detector head shall be exposed when tests call for the exposure of the remote detector head to a specified test gas or other specified set of conditions. Dummy electrical loads (e.g. — fixed resistors) may be substituted for additional detector heads, but if additional detector heads are used, all other detector heads shall be exposed to clean air and normal conditions as described in [7.4.2 through 7.4.4](#).

**7.4.7** The instrument under test may be adjusted or recalibrated prior to the start of each of the tests described in [7.7 through 7.20](#). However, no further adjustments or recalibration shall be carried out for the duration of that test, except where specifically permitted by the particular test procedure.

**7.4.8** Unless otherwise indicated herein, the instrument shall be allowed to stabilize under each different test condition before measurements are taken for comparison purposes.

**NOTE** — An instrument shall be considered to be stabilized when three successive observations of the indication taken at 5-minute intervals indicate no further significant change from the initial reading. A significant change is defined as a variation greater than 2 percent of range or 5 ppm, whichever is less.

**7.4.9** For selectable range instruments, the tests of [7.9 through 7.17](#) shall be performed with the instrument set at all ranges unless specifically stated otherwise.

## 7.5 Non-powered transportation

To evaluate instruments for typical transportation environmental ranges, all parts of the gas detection instrument shall be exposed sequentially to the following conditions:

- a) temperature of -35°C (-31°F) and ambient barometric pressure for at least 24 hours;
- b) ambient temperature and humidity for at least 24 hours;
- c) temperature of +55°C (131°F) and ambient barometric pressure for at least 24 hours; and
- d) ambient temperature and humidity for at least 24 hours.

## 7.6 Drop test

**7.6.1** This test is applicable only to portable instruments.

**7.6.2** While in the operating mode, the instrument (less any removable case, unless otherwise specified by the manufacturer) shall be released from a height of 1.0 m (3.3 ft.) above a concrete surface, and allowed to free-fall.

**7.6.3** The test required by 7.6.2 shall be performed three separate times, each time released with a different surface, edge, or corner of the instrument facing down at the time of release.

**7.6.4** The instrument shall be considered to fail this test if it is inoperative after the test.

**NOTE** – Failures resulting from this test may not become apparent until future tests are conducted.

**7.6.5** For the tests of 7.6, multi-range instruments need to be tested only on one range.

## 7.7 Vibration

**7.7.1** The vibration test machine shall be capable of producing a vibration of variable frequency and adjustable constant excursion (or adjustable constant acceleration peak) with the instrument under test mounted in place, as required by the test procedure.

**7.7.2** While in the operating mode in clean air, all instruments shall be mounted on the vibration test machine and vibrated successively in each of three mutually perpendicular directions, respectively parallel to the edges of the instrument. The instrument shall be mounted on the vibration test machine in the same manner and position as intended for service, using any resilient mounts, carriers, or holding devices that are provided as a standard part of the instrument. The instrument shall be vibrated over a frequency range of 10 Hz to 30 Hz at a total excursion of 1.0 mm (.04 in.), and 31 Hz to 100 Hz at a 2g peak acceleration for a period of one hour in each of three mutually perpendicular directions. The rate of change of frequency shall not exceed 10 Hz per minute (Hz/min.).

**7.7.3** The instruments shall not give any false alarms; there shall be no loose components or damage to the enclosure that could cause a shock hazard. The instrument shall be considered to fail this test if it is inoperative after the test.

**NOTE** – Failures resulting from this test may not become apparent until future tests are conducted.

## **7.8 Initial calibration and set-up**

**7.8.1** The instrument shall be calibrated for testing in accordance with this Standard by using the manufacturer's recommended calibration equipment and specified calibration procedures.

**7.8.2** For instruments containing meters or other concentration indicators, the instrument shall be adjusted to display the concentration(s) of the known calibration gas(es) applied to the detector head. Unless otherwise specified by the manufacturer, at least one calibration gas shall be a minimum of 50 percent of the selected range over which the instrument is to be calibrated. The manufacturer's recommended calibration equipment shall be capable of matching the results of the intended method of gas monitoring within 5 ppm or 10 percent, whichever is greater.

## **7.9 Accuracy**

**7.9.1** For instruments having meters or output signals, the detector head shall be exposed to clean air and mixtures of carbon monoxide in clean air by the intended method of gas monitoring or alternate gas presentation method verified by the tester. Compositions of the mixtures shall be 20 to 30 percent, 40 to 60 percent, and 70 to 90 percent of range. In each case, the concentration indicated by the meter or output signal shall not vary from the known test gas concentration by more than 5 ppm or 10 percent of gas concentration, whichever is greater. For instruments having selectable ranges, the instrument shall be tested on all ranges.

**7.9.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 5 ppm or 10 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 5 ppm or 10 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each test gas concentration shall not be less than 5 minutes or greater than 10 minutes.

**7.9.3** For sample-draw instruments, the accuracy test shall be conducted at both the minimum and the maximum sample flow rates given by the manufacturer. Unacceptable performance at either flow rate shall constitute failure of the test.

## **7.10 Repeatability**

**7.10.1** For instruments having meters or output signals, the detector head shall be exposed to clean air and mixtures of carbon monoxide in clean air by the intended method of gas monitoring or alternate gas presentation method verified by the tester. Compositions of the mixture shall be 70 to 90 percent of range. The test gas shall be applied three times to the instrument, allowing a maximum of 180 seconds between exposures. In each case, the concentration indicated by the meter or output signal shall not vary from the average indication by more than 3 ppm or 5 percent of indication, whichever is greater. For instruments having selectable ranges, the instrument shall be tested on all ranges.

**7.10.2** For alarm-only instruments, the highest alarm setpoint shall be tested. The test gas shall be applied three times to the instrument, allowing a maximum of 180 seconds between exposures.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.10.3** For sample-draw instruments, the repeatability test described above shall be conducted at both the minimum and the maximum sample flow rates given by the manufacturer. Unacceptable performance at either flow rate shall constitute failure of the test.

## **7.11 Step change response and recovery**

**NOTE** – For instruments having multiplexed or scanned channels, the step change response and recovery test must be conducted while scanning all channels.

**7.11.1** For instruments having meters or output signals, after initially being in clean air, the detector head shall be exposed suddenly to a test gas at atmospheric pressure having a concentration corresponding to 95 to 100 percent of range. From the instant of exposure to this gas mixture, the instrument shall respond to provide an indication as follows:

- a) a minimum of 20 percent of the test gas concentration within 12 seconds; and
- b) a minimum of 50 percent of the test gas concentration within 40 seconds.

**7.11.1.1** When stabilization has occurred, the test gas shall be removed and the detector head exposed to clean air. The indication shall decline below 50 percent of the maximum indicated gas concentration within 45 seconds and below 10 percent of the maximum indicated gas concentration within 150 seconds.

**7.11.1.2** For sample-draw instruments, the transportation lines should be as short as practical.

**NOTE** – The Step Change Response and Recovery Test evaluates response times for the instruments only; it does not consider transport time of sample lines.

**7.11.1.3** For sample-draw instruments, the manufacturer's stated response times for maximum sample line length and size and lag times shall be verified.

**7.11.2** For alarm-only instruments, after initially being in clean air, the detector head shall then suddenly be exposed to gas concentrations of 500 percent of the values of the alarm setpoint concentrations. All alarms shall be tested and all shall respond within 12 seconds of exposure to the test gas.

**7.11.2.1** After two minutes, the test gas shall be removed and the detector head exposed to clean air. All alarms shall clear or be resettable within 150 seconds.

## 7.12 Supply voltage variation

**7.12.1** For gas detection instruments that are intended for operation on ac power supply systems and that have the detector head exposed to either clean air or test gas as noted, the supply voltage shall first be decreased to 85 percent of nominal voltage and then increased to 110 percent of nominal voltage. Adjustable alarms shall be set to operate at 35 ppm or 50 percent of selected gas concentration range, whichever is less. As a result of this test, there shall be no instrument malfunction or false actuation of the alarm(s).

**NOTE** – The method of causing these step changes in voltage shall simulate the effect of a heavy load being added to or removed from the source of supply; that is, there shall be no actual interruption of the voltage supply during the voltage transition.

**7.12.1.1** For instruments having meters or other outputs, with the detector head exposed to a concentration of 50 percent of the selected range, the variation in the meter or other output from the initial reading at nominal voltage shall not exceed 5 ppm or 10 percent, whichever is greater.

**7.12.1.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) Alarm(s) shall NOT be activated when the detector head is exposed to clean air.
- d) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.12.2** For gas detection instruments intended for operation on dc power supply systems, with the detector head exposed to either clean air or test gas as noted, the supply voltage shall first be decreased to 87.5 percent of nominal voltage and then increased to 122.5 percent of nominal voltage. Adjustable alarms shall be set to operate at 35 ppm or 50 percent of the selected gas concentration range, whichever is less. As a result of this test, there shall be no instrument malfunction or false activation of the alarm(s).

**NOTE:** The method of causing these step changes in voltage shall simulate the effect of a heavy load being added to or removed from the source of supply; that is, there shall be no actual interruption of the voltage supply during the voltage transition.

**7.12.2.1** For instruments having meters or other outputs, with the detector head exposed to a concentration of 50 percent of the selected range, the variation in the meter or other output from the initial reading at nominal voltage shall not exceed 5 ppm or 10 percent, whichever is greater.

**7.12.2.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.

- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) Alarm(s) shall NOT be activated when the detector head is exposed to clean air.
- d) The time of exposure to each test gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.12.3** For instruments containing integral batteries, the voltage variation shall correspond to the maximum terminal voltage of fresh or fully charged batteries and the voltage at which the low-battery voltage alarm activates. This voltage must be within 5 percent of the minimum operating voltage given by the manufacturer. Instruments having provision for adjustment to compensate for battery voltage decline may be so adjusted. During this test, the detector head shall be exposed to clean air or the test gas, as noted. Adjustable alarms shall be set to operate at 35 ppm or 50 percent of the selected gas concentration range, whichever is less. As a result of this test, there shall be no instrument malfunction or false actuation of the alarm(s).

**7.12.3.1** For instruments having meters or other outputs, with the detector head exposed to a test gas concentration of 50 percent of the selected range, the variation in the meter or other output from the initial reading at maximum battery voltage shall not exceed 5 ppm or 10 percent, whichever is greater.

**7.12.3.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) Alarm(s) shall NOT be activated when the detector head is exposed to clean air.
- d) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.12.4** Gas detection instruments intended for operation from an external power source shall be subjected to five momentary power interruptions, ranging from approximately 0.1 seconds to 5 seconds, with the detector head exposed to clean air. Following each interruption, the instrument shall be allowed sufficient time (not to exceed 150 seconds) to return to normal operating conditions. There shall be no incorrect instrument functions when the primary power is interrupted (applied or removed), with the detector exposed to both clean air and test gas of a concentration exceeding the lowest alarm setting by 5 ppm or 10 percent, whichever is greater.

**7.12.5** Gas detection instruments containing integral batteries shall be subjected to five momentary power interruptions, ranging from approximately 0.1 seconds to 5 seconds, with the detector head exposed to clean air. Following each interruption, the instrument shall be allowed sufficient time (not to exceed 150 seconds) to return to normal operating conditions. This may include turning the instrument ON. There shall be no incorrect instrument functions when the primary power is interrupted (applied or removed), with the detector exposed to both clean air



and test gas of a concentration exceeding the lowest alarm setting by 5 ppm or 10 percent, whichever is greater.

**7.12.6** Output inhibit circuits activated upon power application are permitted, provided the status of the inhibit is visually indicated.

## **7.13 Temperature variation**

All gas detection instruments first shall be calibrated in accordance with 7.8, with all parts of the instrument at ambient temperature. The instrument then shall be placed in a test chamber. The temperature of the test chamber shall be adjusted first to 50°C (122°F), then ambient, and then -10°C (14°F). Stabilization time shall be as stated by the manufacturer, but not less than 2 hours. Then, the detector head shall be exposed to a test gas concentration of 50 percent of the selected range and tested at each temperature.

**7.13.1** For instruments with meters or other output signals and the detector head integral with or directly attached to the control unit, the entire instrument shall be placed in the test chamber. At the two temperature extremes, the meter or output indication shall not vary from the initial stabilized ambient temperature meter or output indication by more than 5 ppm or 10 percent, whichever is greater.

**7.13.2** For instruments with meters or other output signals and a separate (non-integral) detector head, the control unit shall be placed in the test chamber at both temperature extremes while the detector head remains at ambient temperature. The detector head shall be placed in a test chamber at both temperature extremes while the control unit remains at ambient temperature. At the two temperature extremes, the meter or output indication shall not vary from the initial stabilized ambient temperature meter or output indication by more than 5 ppm or 10 percent, whichever is greater.

**7.13.3** For alarm-only instruments, all alarm setpoints shall be tested at the two temperature extremes, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) At -10°C (14°F) alarms shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) At -10°C (14°F) alarms shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration .
- c) At 50°C (122°F) alarms shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever is greater.
- d) At 50°C (122°F) alarms shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- e) The time of exposure to each gas concentration shall not be less than 5 minutes or greater than 10 minutes.

## 7.14 Humidity variation

- a) The detector head shall be exposed to 15 percent or less relative humidity (RH) at ambient temperature for 2 hours. The detector head shall then be exposed to ambient temperature test gas of a concentration of 50 percent of the selected range and a relative humidity of 15 percent or less.
- b) The detector head shall then be exposed to 50 percent RH at ambient temperature for 2 hours. The detector head shall then be exposed to ambient temperature test gas of a concentration of 50 percent of the selected range and 50 percent RH.
- c) The detector head shall then be exposed to at least 90 percent RH at ambient temperature for 2 hours. The detector head shall then be exposed to ambient temperature test gas of a concentration of 50 percent of the selected range and at least 90 percent RH.

**NOTE** – Relative humidity values shall be accurate within 5 percent.

**7.14.1** For instruments having meters or other output signals, the meter and output indications at each humidity extreme shall not vary from the 50 percent RH exposure indication by more than 5 ppm or 10 percent, whichever is greater after correcting for displacement by water vapor.

**7.14.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

## 7.15 Position sensitivity

**7.15.1** For portable instruments having meters or other outputs, with the detector head exposed to a test gas concentration of 50 percent of the selected range, the variation in the meter or other output from the initial reading shall not exceed 5 ppm or 10 percent, whichever is greater, when the orientation of the instrument is varied in three orthogonal planes.

**7.15.2** For alarm-only instruments, all alarm setpoints shall be tested when the orientation of the instrument is varied in three orthogonal planes, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.

- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

## 7.16 Air velocity variation

**7.16.1** The instrument shall be calibrated with the detector head exposed to a still mixture of calibration gas. Then, it shall be exposed to a flowing test gas that impinges on the detector head with a velocity of  $5 \pm 0.5$  m/s ( $16.5 \pm 1.7$  f/s). During this test, the direction of the air velocity or the orientation of the detector head shall be varied to determine the direction or orientation that causes the greatest deviation.

**7.16.1.1** For instruments having meters or other output signals, the meter or other output signal (during exposure to the mixture in motion) shall not vary from that observed during exposure to the still gas mixture by more than 5 ppm or 10 percent, whichever is greater.

**7.16.1.2** For alarm-only instruments, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

## 7.17 Radio frequency interference (RFI)

The instruments (including detector head, electronics, and interconnecting wiring) shall be subjected, while in all energized modes (e.g. — operating and calibrating), to electromagnetic energy in the frequency ranges of 150 to 170 MHz and 450 to 470 MHz. This test shall be conducted using frequency-modulated portable radio transmitters (5 W maximum output from the final amplifier) at a distance of 1.0 meter (3.3 feet) from the instrument (i.e., the gas-sensing element, electronics, and any interconnecting wiring) at any orientation. Tests shall be conducted using any convenient frequency within each of the two frequency ranges. Tests shall be conducted after following the manufacturer's recommendations concerning wiring, shielding, and installation techniques as they pertain to electromagnetic interference.

**NOTE** — Except for portable instruments, covers shall be removed when tests are conducted if the covers must be removed for calibration.

**7.17.1** For instruments incorporating meters or other output signals, the radio signals shall not cause a variation in the meter or other output from the initial reading of more than 5 ppm or 10 percent, whichever is greater, with test gas of a concentration of 50 percent of the selected range applied. For all instruments, the test shall not result in an incorrect instrument function.

**7.17.2** For alarm-only instruments, all alarm setpoints shall be tested with RF present, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.

## 7.18 Long-term stability

For battery-operated instruments, a suitable dc power supply or fresh batteries may be used for the test of 7.18, but the actual batteries specified for the instrument shall be used for the first 8 hours. Portable instruments shall be ON for 8 hours minimum and OFF for 16 hours maximum. The instruments shall be exposed to the clean air or test gas mixture as noted continuously (except when batteries are being exchanged or when adjustments are being made). Calibration shall be performed as recommended by the manufacturer. For multi-range instruments, the test of 7.18 needs to be performed only on the highest range, unless otherwise specified.

**7.18.1** For instruments incorporating meters or output signals, calibrate or adjust the instrument on a test gas concentration of 50 percent of the selected range and keep the power ON for the duration of this test.

**7.18.1.1** Subject the detector head to clean air at ambient temperature and humidity for a period of 21 days.

**7.18.1.2** Apply test gas of a concentration of 50 percent of the selected range to the detector head. The indicated concentration shall not deviate from the initial reading observed in 7.18.1 by more than  $\pm 5$  ppm or 10 percent, whichever is greater. The reading shall be taken after stabilization.

**7.18.1.3** Subject the detector head to a continuous carbon monoxide in air concentration of  $5 \pm 2$  ppm for a period of 14 days.

**NOTE** – A precise concentration is unnecessary. This test is provided only to test the instruments after exposure to a low background level of carbon monoxide.

**7.18.1.4** Remove the test gas for five minutes and repeat 7.18.1.2.

**7.18.1.5** Subject the detector head to clean air at ambient temperature and humidity for a period of seven days.

**7.18.1.6** Apply test gas having a concentration of 50 percent of the selected range to the detector head. The indicated concentration shall not deviate from the reading observed at 7.18.1.2 by more than 5 ppm or 10 percent, whichever is greater. The reading shall be taken after stabilization.

**7.18.1.7** Calibrate the instrument per 7.8.

**7.18.1.8** Apply a carbon monoxide-in-air concentration of 35 ppm for 8 hours. The indicated concentration shall not deviate from the actual applied concentration by more than  $\pm 5$  ppm. The reading shall be taken after stabilization.

**7.18.1.9** Calibrate the instrument per 7.8.

**7.18.1.10** Repeat the accuracy test per [7.9](#).

**7.18.2** For alarm-only instruments, calibrate the instrument per [7.8](#) and then proceed.

**7.18.2.1** Subject the detector head to clean air at ambient temperature and humidity for a period of 21 days.

**7.18.2.2** All alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever is greater.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.18.2.3** Subject the detector head to a continuous carbon monoxide in air concentration of  $5 \pm 2$  ppm for a period of 14 days.

**NOTE** – A precise concentration is unnecessary. This test is provided only to test the instruments after exposure to a low background level of carbon monoxide.

**7.18.2.4** Remove the test gas for five minutes and repeat the tests of [7.18.2.2](#).

**7.18.2.5** Subject the detector head to clean air at ambient temperature and humidity for a period of seven days.

**7.18.2.6** Repeat the tests of [7.18.2.2](#).

**7.18.2.7** Calibrate the instrument per [7.8](#).

**7.18.2.8**

- a) Apply a test gas concentration equivalent to 5 ppm below the alarm setpoint for 8 hours. During this time the alarm shall not activate.
- b) Apply a concentration equivalent to 5 ppm above the alarm setpoint for 8 hours. During this time the alarm shall stay activated and shall not be resettable.

**7.18.2.9** Calibrate the instrument per [7.8](#).

**7.18.2.10** Repeat the test of [7.18.2.2](#).

## 7.19 Battery and low-battery voltage alarm

**7.19.1** This clause is applicable only to instruments powered by integral batteries (excluding batteries used only for memory retention). This test is intended to verify that portable instruments will operate for specified time periods without exchanging or recharging batteries.

**7.19.2** Calibrate or adjust the instrument with a test gas concentration of 50 percent of the selected range.

**7.19.3** Subject the instrument to clean air at a nominal temperature of -10°C (14°F) for 8 hours. The 8-hour period shall include a continuous 15-minute period of maximum-load conditions (alarms, lights, etc., activated). Instruments having provisions for adjustment to compensate for battery voltage decline may be adjusted.

**7.19.4** For instruments having meters or output signals, at the end of the 8 hours specified in 7.19.3, the detector head shall be exposed to a test gas having a concentration of 50 percent of the selected range. The indicated concentration shall not deviate from the initial reading observed in 7.19.2 by more than  $\pm 5$  ppm or 10 percent, whichever is greater.

**7.19.5** For alarm-only instruments, at the end of the 8 hours specified in 7.19.3, all alarm setpoints shall be tested, with the lowest alarm setpoint of multiple alarm setpoint units tested first.

- a) Alarm(s) shall be activated by a test gas concentration of 10 ppm or 20 percent *above* the alarm setpoint concentration, whichever represents the higher concentration.
- b) Alarm(s) shall NOT be activated by a test gas concentration of 10 ppm or 20 percent *below* the alarm setpoint concentration, whichever represents the lower concentration.
- c) The time of exposure to each gas concentration shall neither be less than 5 minutes nor greater than 10 minutes.

**7.19.6** Remove the test gas. Operate the instrument with batteries that are approaching the low-battery alarm point until the alarm activates. The alarm must operate for a minimum of five minutes.

## 7.20 Exposure to high-concentration gas

**CAUTION – CARBON MONOXIDE IS A TOXIC GAS, AND EXPOSURE MAY RESULT IN LOSS OF CONSCIOUSNESS OR DEATH.**

**7.20.1** The detector head of instruments shall be subjected to a step change in gas concentration from clean air to 4000 ppm test gas. Sample-draw instruments shall be subjected to this test, using the shortest practical sample tubing and operated within the flow rate range recommended by the manufacturer. The instrument shall produce an alarm output within five seconds of exposure to the gas. Exposure in the alarm condition shall continue for five minutes.

**7.20.1.1** Following removal of the test gas, the detector head shall be exposed to clean air.

**7.20.1.2** Instruments incorporating meters or output signals shall produce an output of less than 35 ppm within 10 minutes.

**7.20.1.3** Alarm-only instruments with alarm setpoint(s) adjusted to 35 ppm or 50 percent of selected range (whichever is less) shall not indicate an alarm condition and shall be resettable within 10 minutes.

**7.20.1.4** For all instruments except alarm-only units, 30 to 45 minutes after the removal of the test gas and exposure to clean air, the instrument will be exposed to a test gas concentration of 50 percent of the selected range. The indicated concentration shall not deviate from the reading observed at the most recent calibration at 50 percent of the selected range by more than 5 ppm or 10 percent, whichever is greater. The reading shall be taken after stabilization. The instrument must meet the requirements of [7.9](#).

**7.20.1.5** For alarm-only instruments, 30 to 45 minutes after the removal of the test gas and exposure to clean air, the instrument shall be tested in accordance with the requirements of [7.18.2.2](#).





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## Annex A – References

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This annex is included for informational purposes and is not part of this Standard.

The following standards contain provisions that, through reference in this text, constitute provisions of this ISA Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

### AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

Threshold Limit Values for Chemical Substances in Environment Adopted by ACGIH for 1994-1995.

**Available from:**           **ACGIH**  
6500 Glenway Avenue  
Bldg. D-7  
Cincinnati, OH 45211  
Tel: (513) 661-7881

### AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

1985   Manual of Recommended Practice for Portable  
Reading Carbon Monoxide Indicators

**Available from:**           **AIHA**  
2700 Prosperity Avenue #250  
Fairfax, VA 22031-4311  
Tel: (703) 849-8888

### AMERICAN PETROLEUM INSTITUTE (API)

RP 14C-1984	Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms
RP 14F-1991	Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms
RP 49-1987	Recommended Practices for Safe Drilling of Wells Containing Hydrogen Sulfide
RP 55-1983	Conducting Oil and Gas Production Operations Involving Hydrogen Sulfide
RP 500-1997	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2

RP505 Recommended Practice for Classification of Locations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2

**Available from:** **API**  
1220 L Street NW  
Washington, DC 20005 Tel: (202) 682-8000

#### **BRITISH STANDARDS INSTITUTE (BSI)**

BS.5345 Code of Practice in Selection, Installation, and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres (other Than Mining Applications for Explosive Processing and Manufacture) Parts 1 - 9

**Available from:** **BSI**  
Newton House  
101 Pentonville Road  
London, N19ND  
England Tel: 44 01-837-8801

#### **CANADIAN STANDARDS ASSOCIATION (CSA)**

C22.2 No. 0.4 Bonding and Grounding of Electrical Equipment (Protective Grounding)

C22.2 No. 152 Combustible Gas Detection Instruments

**Available from:** **CSA**  
178 Rexdale Boulevard  
Rexdale, Ontario M9W 1R3  
Canada Tel: (416) 747-4044

#### **FACTORY MUTUAL RESEARCH CORPORATION (FMRC)**

Approval Standard Intrinsically Safe Apparatus and Associated  
Class No. 3610 Apparatus for Use in Class I, II, and III, Division 1, Hazardous Locations

Approval Standard Electrical Equipment for Use in Class I and II,  
Class No. 3611 Division 2, and Class III, Divisions 1 and 2, Hazardous Locations

Approval Standard Explosionproof Electrical Equipment  
Class No. 3615

Approval Standard Electrical Utilization Equipment

Class No. 3812

**Available from:**

**FMRC**

1151 Boston-Providence Turnpike  
Norwood, MA 02062

Tel: (617) 762-4300

**INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)**

Std. 142-82 Recommended Practice for Grounding of Industrial and Commercial  
Power Systems

Std. 315-75 Graphic Symbols for Electrical and Electronics Diagrams

**Available from:**

**IEEE**

P.O. Box 1331  
445 Hoes Lane  
Piscataway, NJ 08855-1331

Tel: (800) 678-4333

**ISA**

ANSI/ISA-S5.5-1985 Graphic Symbols for Process Displays

ISA-S12.1-1991 Definitions and Information Pertaining to Electrical  
Instruments in Hazardous (Classified) Locations

ISA-S12.4-1970 Instrument Purging for Reduction of Hazardous Area  
Classification

ANSI/ISA-RP12.6-1995(R) Wiring Practices for Hazardous (Classified) Locations  
Instrumentation, Part I: Intrinsic Safety

ANSI/ISA-RP12.13-1986(RA) Part I: Performance Requirements, Combustible Gas  
Detectors

ISA-RP12.13-1987 Part II: Installation, Operation, and Maintenance of  
Combustible Gas Detection Instruments

ANSI/ISA-S51.1-1993(RA) Process Instrumentation Terminology

ANSI/ISA-S71.04-1986 Environmental Conditions for Process Measurement and  
Control Systems: Airborne Contaminants

ANSI/ISA-S82.01-1994(R) Safety Standard for Electrical and Electronic Test,  
Measuring, Controlling and Related Equipment — General  
Requirements

ANSI/ISA-S82.02.02-1996	Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment — Electrical and Electronic Test and Measuring Equipment
ANSI/ISA-S82.03-1988	Safety Standard for Electrical and Electronic Test, Measuring, Controlling and Related Equipment — Electrical and Electronic Process Measurement and Control Equipment
ISA-dS92.02.01-1997	Performance Requirements for Carbon Monoxide Detection Instruments
SAMA PMC 33.1-1978	Electromagnetic Susceptibility of Process Control Instrumentation. (Under revision as potential ISA Standard; currently designated as ISA-dS71.05, ISA-dS71.06, and ISA-dS71.07.)

Bossert, John A., "Performance Certification of Combustible Gas Detectors," presented at ISA International Symposium, 1976.

Schaeffer, M.J., "The Use of Combustible Detectors in Protecting Facilities from Flammable Hazards," ISA Transactions. Vol. 20, No. 2.

**Available from:** **ISA**  
67 Alexander Drive  
PO Box 12277  
Research Triangle Park, NC 27709 Tel: (919) 990-9200

#### **INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)**

654-1 Temperature, Humidity, and Barometric Pressure.

**Available from:** **IEC**  
3, rue de Varembe  
P.O. Box 131  
1211 Geneva 20  
Switzerland Tel: 41 22 734 0150

#### **NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)**

MR-01-75 Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment

**Available from:** **NACE**  
1440 South Creek Drive  
PO Box 218340  
Houston, TX 77218-8340

Tel: (713) 492-0535

#### **NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)**

No. 70	National Electrical Code
No. 493	Intrinsically Safe Apparatus for Use in Division 1 Hazardous Locations
No. 496	Standard for Purged and Pressurized Enclosures for Electrical Equipment

**Available from:** **NFPA**  
One Batterymarch Park  
P.O. Box 9101  
Quincy, MA 02269-9101

Tel: (617) 770-3000

#### **NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)**

Criteria Documents on Chlorine and Sulfur Dioxide

**Available from:** **NIOSH**  
MS C-21  
4676 Columbia Pkwy.  
Cincinnati, OH 45226-1998

Tel: (800) 35-NIOSH

#### **UNDERWRITERS LABORATORIES, INC. (UL)**

UL 913	Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations
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**Contact:** **UL**  
333 Pfingsten Road  
Northbrook, IL 60062

Tel: (708) 272-8800

#### **UNITED STATES CODE OF FEDERAL REGULATIONS (CFR)**

Title 29, Part 1910	Occupational Safety and Health Standards, Subpart S, Electrical
Title 30, Part 250 and 256 (April 1, 1988)	Oil and Gas and Sulphur Operations in the Outer Continental Shelf

Title 46, Parts 154,  
1345 and 1350

U.S. Coast Guard Regulations for Gas Detection and Gas  
Detection Systems on Self-propelled Vessels Carrying Bulk  
Liquefied Gases

**Available from:**

**GPO**

Superintendent of Documents  
U.S. Government Printing Office  
Washington D.C. 20402



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