



Member of the FM Global Group

Examination Standard for Toxic Gas and Oxygen Depletion Detectors

Class Number 6340

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1 INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for toxic gas and oxygen depletion gas detection instruments.
- 1.1.2 Testing and certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2 Scope

- 1.2.1 This standard sets performance requirements for the construction and testing of toxic gas and oxygen depletion gas detection instruments. Instruments used to detect flammable (explosive) concentrations of toxic gas(es) when the LFL exceeds the TLV are excluded.
- 1.2.2 For apparatus used for sensing the presence of multiple gases that are both toxic and flammable, this document applies only to the portion sensing the presence of toxic gas or vapor.

Note: Some gases may be both toxic and flammable, and even though the concentrations required to reach the flammable limit are typically many times greater than the toxic levels, consideration of the gas detector method of protection for hazardous locations should be made when using toxic gas detectors in locations where flammable gases may be present.

- 1.2.3 This standard does not address gas monitoring or monitoring apparatus of the laboratory or scientific type used for analysis or measurement, apparatus used for process control and process monitoring purposes, or apparatus used for residential purposes.
- 1.2.4 The user should be aware of environmental effects on both the instrument and the toxic gas. The effects are not intended to be evaluated by this standard.
- 1.2.5 Toxic Gases (for gases listed in ANSI/ISA-92.00.01-2010)

Note: The 2010 edition is considered to be the minimum requirements. A later edition is permitted to be used once published.

- 1.2.5.1 Toxic gas detectors for the detection of the gases listed in ANSI/ISA-92.00.01 shall comply with the requirements of this standard and all applicable requirements in ANSI/ISA-92.00.01 including acceptance criteria as defined within Annex A of ANSI/ISA-92.00.01.
- 1.2.6 Toxic Gases (for gases not listed in ANSI/ISA-92.00.01-2010)

1.2.6.1 Toxic gas detectors for the detection of the gases not listed in ANSI/ISA-92.00.01-2010 shall comply with the requirements of this standard and all applicable requirements in ANSI/ISA-92.00.01-2010 with acceptance criteria defined as the manufacturer's claimed performance for each gas type. The performance parameters shall be clearly identified within the manufacturer's instruction manual. The performance parameters of each gas shall include **all** of the following:

the gas name and common formula

range(s) (for multiple ranges performance parameters shall be stated for each range)

accuracy (to be in the format: "± xx ppm or ± xx % of reading whichever is greater")

Response Time (T20), Response Time (T50), Response Time (T90), Recovery Time (T10).

Response and Recovery time shall be of Final Value (seconds), where Final Value = value

after stabilization.

Temperature range over which the stated accuracy applies.

1.2.7 Oxygen Depletion

1.2.7.1 Gas detectors for the detection of oxygen levels below 21% by volume shall comply with the requirements of this standard and all applicable requirements in ANSI/ISA-92.04.01-1996.

Note: The 1996 edition is considered to be the minimum requirements. A later edition is permitted to be used once published.

1.2.8 Common Low Concentration Gases

1.2.8.1 For a gas detector which measures a gas that is also flammable, this standard is applicable for ranges from ppm level up to 3% of the lower flammable limit. For example, hydrogen – with an LFL of 4%v/v (40,000 ppm) shall be tested as a toxic gas up to a concentration of 1200 ppm. Measurement levels above 1200 ppm shall be tested as a flammable gas.

1.3 Basis for Requirements

1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, and loss control specialists was also considered.

1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of toxic and oxygen depletion gas detectors for the purpose of obtaining certification. Toxic and oxygen depletion gas detectors having characteristics not anticipated by this standard may be certified if performance equal or superior to that required by this standard is demonstrated.

1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1 Examination and tests on production samples shall be performed to evaluate:

- the suitability of the product;
- the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
- the durability and reliability of the product.

1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be made to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance shall be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5 Basis for Continued Certification

Continued certification is based upon:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;

- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements;
- satisfactory surveillance audits conducted as part of the certification agencies product surveillance program.

1.6 Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this Standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Where units of measurement are expressed in U.S. customary units, they are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. Conversions are in accordance with ANSI/IEEE/ASTM SI-10. Where units of measurement are expressed in SI units, no US customary units are provided.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies:

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

ANSI/ISA-92.00.01, Performance Requirements for Toxic Gas Detectors,

ANSI/ISA-92.04.01, Part I, Performance Requirements for Instruments Used to Detect Oxygen-Deficient/Oxygen-Enriched Atmospheres

FM Approvals Examination Standard 3600, General Requirements for Electrical Equipment

1.9 Definitions

For purposes of this standard, the definitions within ANSI/ISA-92.00.01 and ANSI/ISA-92.04.01, Part I apply, including the following additional terms:

Aspirated Apparatus — An apparatus which samples the atmosphere by drawing it to the sensor, for example by means of a hand operated or electric pump.

Dead Space — An actual or potential area within a chamber where the gas is stagnant (not mixing and/or still)

Fault Signal — An audible, visible, or other type of output providing, directly or indirectly, a warning or indication that the apparatus is not working satisfactorily.

Zero Indication — (excluding oxygen gas detector) The indication given by properly adjusted apparatus when exposed to clean air in normal operating conditions.

Special State — All states of the apparatus other than those in which monitoring of gas concentration takes place, for example warm-up, calibration mode or fault condition.

Transmitter — Stand-alone gas detection apparatus for use with separate control units includes apparatus that provide a conditioned electronic signal or output indication intended to be used with stand-alone control units, separate signal processing, data acquisition, central monitoring or other similar systems which typically process information from various locations and sources including, but not limited to, gas detection instrumentation.

2 GENERAL INFORMATION

2.1 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance manuals, and
- the number and location of manufacturing facilities.

All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.2 Requirements for Samples for Examination

2.2.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- test samples will typically be a complete assembly with all components mounted in a manner consistent with the manufacturer's instructions and intended application;
- sample requirements to be determined by the certification agency

2.2.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.2.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.2.4 It is the manufacturer's responsibility to provide any necessary test fixtures required to test their specific design.

2.2.5 Additional tests may be required, at the discretion of the certification agency, depending on design features and results of any foregoing tests.

2.2.6 Any test following a failure shall be acceptable only at the discretion of certification agency and with a technical justification of the conditions or reasons for failure.

3 GENERAL REQUIREMENTS

3.1 Review of Documentation

If any of the manufacturer's published claims exceed any of the test condition extremes described in Section 5, the tests shall be conducted under the conditions for which the claims apply.

All claims not tested and verified by the certification agency as part of the certification investigation must be clearly identified as such in the product's installation and operation manual. Alternatively, the manufacturer may include a section or appendix in the manual which clearly itemizes the specifications, features, functions and restrictions included in the certification.

Electrical assemblies and components shall comply with the construction and test requirements of Section 4, where applicable. In addition, parts of the apparatus intended for use in hazardous (classified) locations shall employ materials and comply with the construction and explosion protection as specified in the appropriate standards.

3.2 Markings

3.2.1 In addition to the marking information required in accordance with FM Approvals Examination Standard 3600, toxic and oxygen depletion gas detection equipment shall be marked with the following information:

- Manufacturer's name or trademark and address (minimum of city and country);
- specific model designation and serial number;
- gas type, measurement range and unit of measurement (see clauses 3.2.2 e-h);
- apparatus electrical ratings (voltage, frequency, current or power);
- apparatus operating ambient temperature range (see clauses 3.2.2. i-k);
- "FM6340";
- "ANSI/ISA-92.00.01" and/or "ANSI/ISA-92.04.01" as applicable;
- certification agency's mark
- certification agency's mark may be supplemented as follows:

CERTIFIED

FOR PERFORMANCE

or

CERTIFIED

FOR PERFORMANCE AND

HAZARDOUS (CLASSIFIED) LOCATIONS

3.2.2 The model or type identification shall correspond to the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.

3.2.3 The certification agency's mark of conformity shall appear legibly and indelibly (markings shall be durable as defined by FM 3600 clause 4.2) on each gas detection apparatus in the following manner, as applicable:

- a. For portable instruments, the marking shall appear both on the outside surface of the instrument and on its carrying case, if the latter obscures the required markings.

- b. For stationary apparatus, the marking shall appear in a location where it will be visible after installation and in direct sight during the routine periodic re-calibration and adjustment of set point(s).
- c. 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.
- d. Where the design of a stationary control unit is such that there is insufficient space for this marking to appear on the portion of the unit that is visible after installation (e.g., compact designs for close panel mounting), the marking is permitted to appear elsewhere on the control unit, provided that a second duplicate label (with an acceptable adhesive) bearing such marking is supplied with each such control unit (or assembly of control units), together with the instructions that it is to be attached by the user in a conspicuous location after installation, as close as possible to the control unit.
- e. For gas detectors with external sensor housings that are interchangeable, gas type and unit of measurement shall be marked on the sensor housing.
- f. For gas detectors with external sensor housings that are not interchangeable, but which have internal sensors that are interchangeable, gas type and unit of measurement shall be marked on the sensor housing and a replacement label and instructions shall be included with each replacement sensor.
- g. For gas detectors with internal sensors that are interchangeable, gas type and unit of measurement shall be marked on the gas detector and replacement labels and instructions shall be included with each replacement sensor.
- h. Fixed apparatus with remote sensors shall carry a label on each sensor indicating the gas to be detected.
- i. For gas detectors with certification for hazardous locations, the temperature range marked on the gas detector shall not exceed the temperature range of the hazardous location certification.
- j. If multiple or interchangeable gas-sensing elements are provided in a common housing, the most restrictive temperature range shall be used.
- k. For gas detectors with remote sensors, both the detector and the sensor shall be marked with a temperature range.

3.2.4 All apparatus 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 3.0 mm high. The balance of the wording shall be in capital letters at least 2.5 mm high.

3.2.5 Where the design of special features of the apparatus requires additional markings or a change in marking requirements, the additions or revisions are allowed, but the safety and instructional intent of this clause shall be met.

3.2.6 The manufacturer shall not use this mark on any other product unless such product is covered by separate agreement with the certification agency.

3.2.7 The range of oxygen-monitoring shall be indicated on the instrument. Any markings on the instrument that refer to this standard shall state that the requirements of this standard apply only to the range from 15 to 25 percent oxygen at one normal atmosphere.

Note 1: For gas detection instruments that comprise a control unit and remote detector head(s), it is sufficient that this marking appear on the control unit only, except if routine re-calibration can be

accomplished entirely by adjustments at the remote detector locations alone, this marking shall appear both on the control unit and on the remote detector head.

Note 2: Gas measurement range and unit of measurement may be eliminated from the label if it is accessible on the instruments display.

3.3 Manufacturer's Installation and Operation Instructions

The Installation and Operation Instruction Manual requirements of ANSI/ISA-92.00.01 and ANSI/ISA-92.04.01 apply with the following additional requirements:

- 3.3.1 A list of operational limitations which include, as applicable, maximum length of lines, loop resistance, and minimum wire size for wiring between the control unit and remote detector head(s); accuracy limits and air velocity limitations.
- 3.3.2 For stationary and mobile sample-draw instruments, wording to provide for a clear indication that suitable flow proving devices must be provided at the time of installation, if applicable.
- 3.3.3 For intermittent-duty and continuous-duty portable gas detection instruments, wording such as:
CAUTION — BEFORE EACH DAY'S USAGE, SENSITIVITY MUST BE TESTED WITH A KNOWN CONCENTRATION OF (specify gas) EQUIVALENT TO 25% TO 50% OF FULLSCALE CONCENTRATION
- Also, wording on the action the user should take if after this test the indication is less than the actual concentration.
- 3.3.4 For alarm only portable gas detection instruments, wording such as:
CAUTION — BEFORE EACH DAY'S USAGE, SENSITIVITY MUST BE TESTED ON A KNOWN CONCENTRATION OF (specify gas) EQUIVALENT TO 5% ABOVE THE ALARM SET POINT OF THE INSTRUMENT. THE ALARM MUST BE ACTUATED DURING THIS CHECK, OR CORRECTIVE ACTIVE TAKEN PER (specify adjustment procedures)
- 3.3.5 For stand-alone detector heads, specifications shall be supplied with the instruments that describe the relationship of the gas concentration detected by the instrument, to the corresponding output signal or indication. Such specifications shall be detailed to the extent that the accuracy of the output or signal indication 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 0, 10, 25, 50, 75 and 100% of full-scale indication. Full-scale output shall be as specified by the manufacturer.
- 3.3.6 For stand-alone detector heads and instruments that provide measurement and alarm outputs (e.g., 4-20 mA signal, relay contacts), the following shall appear in the instruction manual:
"This certification does not include or imply certification of apparatus to which the subject instrumentation may be connected. In order to maintain a certification system, the apparatus to which this instrument is connected, must also be certified by the certification agency."
- 3.3.7 For stand-alone control units, the following shall appear in the instruction manual:
"This certification does not include or imply certification of gas detector heads or other apparatus to which the subject instrument may be connected. In order to maintain a certification system, the measurement input signal to which this instrument is connected must also be certified by the certification agency."

3.3.8 Communication Options

For instruments providing communications options that are not included in the certification examination, the following shall appear in the instruction manual:

“As part of this certification, it was verified that optional communication functions of this gas detection instrument while operating at the maximum transaction rate do not adversely affect the gas detection operation and functions of the instrument. This certification, however, does not include or imply certification of the communications protocol or functions provided by the software of this instrument or of the communications apparatus or software connected to this instrument.”

3.4 Test Apparatus

3.4.1 Mask for Calibration and Tests

When a mask is used for calibration or for the injection of test gas into the sensor, the design and operation of the mask used by the testing laboratory – in particular the pressure and velocity inside the mask – shall not inadmissibly influence the response of the apparatus or the results obtained.

3.4.2 Accuracy tests shall be performed within a sealed chamber. The chamber shall be of a size where the portion of the gas detector entering the chamber does not occupy more than 30% of its total volume. The gas inlet tube(s) shall be situated so as to not directly flow the gas across the sensor. The inlet flow rate shall be at a rate no greater than one test volume exchange per minute for a minimum of five volume exchanges. The gas outlet(s) shall be sized so not to increase the pressure within the chamber by more than 0.10 inches water. The inlet and outlet tubes shall be positioned as to prevent dead spaces within the chamber. A small fan may be added to the test chamber to assure full mixing. The fan shall be turned off prior to taking the reading. The gas shall be fully mixed prior to entering the chamber.

V_c = total internal volume of empty chamber

V_d = volume of the detector that will be placed inside the chamber

V_t = test volume = $V_c - V_d$

Note 1: It is common practice to consider five air exchanges to completely purge a chamber therefore, gas stabilization should not be considered to occur in less than 5 minutes of the start of the gas flow.

Note 2: It may be necessary to pre-condition the gas inlet tubing and the interior of the chamber prior to tests, depending on the gas type and concentration.

3.4.3 Step response tests shall be performed within a chamber which will create a uniform airflow at a rate of 0.5m/s. The flow rate is to be measured at the point where the sensing element is to be inserted into the airstream but measured without the sensor in place. The chamber shall be of a size to allow the air to flow around all portions of the detector including any junction boxes supplied with the detector or remote sensor head. The detector or remote sensor head shall be mounted in the worst case intended orientation.

Note: To create the step change from clean air to the test gas, test unit may either be plunged into the test chamber or installing a protective cover over the sensing element and quickly removing the cover to create the step change.

3.5 Test Gas Concentration

- 3.5.1 For oxygen gas detectors, the test gas concentration shall be as defined within ANSI/ISA-S92.04.01-1996, clause 3.26.
- 3.5.2 For toxic gas detectors, the test gas concentration shall be as follows:
- a. The “test-gas tolerance” shall be as defined within ANSI/ISA-92.00.01-2010, Annex A, Item 1.
 - b. The “test-gas tolerance” is the tolerance of the gas mixture (which may be either a blended mixture directly from a cylinder or a blended mixture that is made at the test station) as the mixture is applied to the sensor face. Therefore, all tolerances (for example, gas cylinder tolerance, flow measurement tolerance, etc.) shall be included in the calculation for the “test-gas tolerance”.
- 3.5.3 When a specific test condition affects the concentration of gas a surrogate gas may be used for that test. The correlation between the surrogate gas and the gas of interest shall be validated prior to any testing.

Note: An example of this would be the humidity test for ammonia. Exposing ammonia gas to humidity will create ammonium hydroxide.

3.6 Calibration

- 3.6.1 Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider’s accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.
- 3.6.2 When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of this equipment.

4 CONSTRUCTION REQUIREMENTS

4.1 General

For purposes of this standard, the construction requirements within ANSI/ISA-92.00.01-2010 and ANSI/ISA-92.04.01, Part I-1996 apply, including the following additional requirements:

- 4.1.1 A unique means shall be provided to alert the user that a gas concentration in excess of the measuring range of the instrument has been detected.
- 4.1.2 Measurement indications and output signals (e.g., current loop, voltage, etc.) of stand-alone detector heads shall have the ability to be calibrated for zero and span, with or without the presence of a control unit (use of simulated control unit input is satisfactory).
- 4.1.3 Measurement input signals (e.g., current loop, voltage, etc.) and indications of stand-alone control units or systems shall have the ability to be calibrated for zero and span, with or without the presence of a detector head (use of simulated detector head output is satisfactory).
- 4.1.4 Auxiliary measurement output signals (e.g., 4-20 mA, voltage, etc.) provided with detector heads or control units shall have the ability to be individually calibrated for zero and span.
- 4.1.5 The effects of the tests required to verify the instrument's suitability for specified locations (dust, rain, hosedown, corrosion tests, etc.) shall be considered as part of performance tests in Section 5.
- 4.1.6 **Special State Indication**
If a special state is entered by an apparatus, this shall be indicated by a signal. For fixed apparatus, this shall include a contact or other transmittable output signal.
- 4.1.7 All apparatus shall be constructed to facilitate regular accuracy checks.
- 4.1.8 All materials and components used in the construction of the apparatus shall be used within the manufacturer's ratings or limitations, unless otherwise specified by appropriate safety standards.
- 4.1.9 **Selectable Range**
If the apparatus has more than one measuring range, the range selected shall be clearly identified.
- 4.1.10 **Indicator Light Marking**
In addition to the color requirements, the indicator lights shall be adequately labeled to show their functions.
- 4.1.11 **Alarm or Output Functions**
- Alarm devices shall not be adjustable to operate outside the measuring range.
 - If it is possible to de-activate alarm devices, output contacts or alarm signal outputs, e.g., for calibration purposes, this deactivation shall be indicated by a signal. For fixed apparatus, this shall include a contact or other transmittable output signal. Alternatively, the output signal or contacts are not required if the alarms are automatically re-enabled within 15 min.
 - Gas-detection apparatus, their components, and remote detector heads must be constructed to be resistant to, or protected against, electromagnetic interference. Testing shall be verified and documented in accordance with EN 50270 by an ISO/IEC 17025 accredited test laboratory.

5 PERFORMANCE REQUIREMENTS

5.1 General

For purposes of this standard, the test methods within ANSI/ISA-92.00.01-2010 and the performance tests within ANSI/ISA-92.04.01, Part I-1996 apply, including the following additional requirements:

5.1.1 Software Requirements

For gas detectors dependent on software/firmware programs for normal operation:

- a. It shall be possible for the user to identify the installed software version, for example by marking on the installed memory component, in (if accessible) or on the apparatus or by showing it on the display during power up or on user command.
- b. It shall not be possible for the user to modify the program code.
- c. Parameter settings shall be checked for validity. Invalid inputs shall be rejected. An access barrier shall be provided against parameter changing by unauthorized persons, e.g., it may be integrated by an authorization code in the software or may be realized by a mechanical lock. Parameter settings shall be preserved after removal of power, and while passing a special state. All user changeable parameters and their valid ranges shall be listed in the manual.
- d. Software shall have a structured design to facilitate testing and maintenance. If used, program modules shall have a clearly defined interface to other modules.
- e. Software documentation shall include:
 - 1) The apparatus to which the software belongs;
 - 2) Unambiguous identification of program version;
 - 3) Functional description;
 - 4) Software structure (e.g., flow chart, Nassi-Schneidermann diagram);
 - 5) Any software modification provided with the date of change and new identification data.
- f. In the design of software-controlled apparatus, the risks arising from faults in the program shall be taken into account.

Note: This may be accomplished by following a software development process in accordance with IEC61508.
- g. All changes to software/firmware shall result in a revision to the release level of the software/firmware and such release level shall be under document control.
- h. Data Transmission

Digital data transmission between spatially separated components of apparatus shall be reliable. Delays resulting from transmission errors shall not extend the response time t_{90} or time to alarm for alarm only apparatus by more than a third. If they do, the apparatus shall pass over to a defined special state. The defined special state shall be documented in the instruction manual.
- i. Self-Test Routines

Computerized digital units shall incorporate self-test routines. On failure detection, the apparatus shall pass over to a defined special state. The defined special state shall be documented in the instruction manual.

The following minimum tests shall be performed by the apparatus:

 - i. power supply of digital units shall be monitored within time intervals of maximum ten times response time $t(90)$ or time to alarm for alarm only apparatus .

- ii. All available visible and audible output functions shall be tested. The test shall be carried out automatically after starting operation or on user request. The result may need to be verified by the user
- iii. watchdog or similar mechanism with its own time base shall work independently and separately from the parts of the digital unit, which perform the data processing;
- iv. Program and parameter memory shall be monitored by procedures, which allow the detection of a single bit error.
- v. Volatile memory shall be monitored by procedures that test the readability and writeability of the memory cells.

The tests except for test b) shall be done automatically and be repeated cyclically equal to or less than 24 h and after switching on.

j. Functional Concept

The manufacturer shall provide documentation for functional concept analysis and evaluation using the following list:

- i. Measuring sequence (including all possible variations),
- ii. Possible special states,
- iii. Parameters and their tolerable adjustment range,
- iv. Representation of measuring values and indications,
- v. Generation of alarms and signals,
- vi. Extent and realization of test routines,
- vii. Extent and realization of remote data transmission.

k. Conversion Errors

The relationship between corresponding analogue and digital values shall be unambiguous. The output range shall be capable of coping with the full range of input values within the instrument specification. A clear indication shall result if the conversion range has been exceeded.

The design shall take into account the maximum possible analogue-to-digital, computational and digital-to-analogue converter errors. The combined effect of digitization errors shall not be greater than the smallest deviation of indication required by this standard.

5.1.2 Accuracy/repeatability of ANSI/ISA-92.00.01-2010, Annex A, Item 2 shall be percent of test gas (not percent of reading).

5.1.3 Vibration

- a. Signal outputs including current and alarm relays shall be continuously monitored throughout the test.
- b. Before, and at the conclusion of the test, oxygen gas detectors shall be exposed to clean air followed by the test gas.

5.2 Test Methods

5.2.1 For the purpose of type testing, the tests shall be carried out on one apparatus. Another apparatus may be used for the long-term stability test however the sample used for long term stability shall have the unpurged storage, vibration and accuracy tests completed prior to the start of the long term stability test.

5.2.2 The requirement of ANSI/ISA-92.00.01-2010 clause 5.2.1 (regarding claimed ingress protection level) shall be applied to oxygen detectors examined to ANSI/ISA-S92.04.01-1996.

5.2.3 Dielectric Test

Following completion of all of the applicable tests of Clause 5, the equipment shall be subjected to dielectric strength tests as required by ANSI/ISA-61010-1, with satisfactory results. This test may be run prior to the completion of the long-term stability test.

6 OPERATIONS REQUIREMENTS

6.1 Demonstrated Quality Control Program

6.1.1 A quality assurance program is required to assure that subsequent gas detector(s) produced by the manufacturer shall present the same quality and reliability as the specific gas detector(s) examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests, and is documented in the certification report.
- Continued conformance to this standard is verified by the Surveillance Audit.
- Quality of performance is determined by field performance and by periodic re-examination and testing.

6.1.2 The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines;
- incoming quality assurance, including testing;
- in-process quality assurance, including testing;
- final inspection and tests;
- equipment calibration;
- drawing and change control;
- packaging and shipping; and
- handling and disposition of non-conforming materials.

6.1.3 Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

6.1.4 Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

6.1.5 Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, must be reported to, and authorized by, the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

6.2 Surveillance Audit

6.2.1 An audit of the manufacturing facility shall be part of the certification agencies surveillance requirements to verify implementation of the quality assurance program. Its purpose is to determine

that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.

- 6.2.2 Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

6.3 Installation Inspections

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

6.4 Manufacturer's Responsibilities

The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.