ISA-RP92.04.02, Part II-1996

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Recommended Practice

Installation, Operation, and Maintenance of Instruments Used to Detect Oxygen-Deficient/Oxygen-Enriched Atmospheres

ISA-RP92.04.02, Part II — Installation, Operation, and Maintenance of Instruments Used To Detect Oxygen-Deficient/Oxygen-Enriched Atmospheres

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Preface

This preface, all footnotes, and annexes are included for informational purposes and are not a part of ISA-RP92.04.02, Part II.

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Contents

1 Scope

1.1 ISA-RP92.04.02, Part II, applies to all oxygen detection instruments that satisfy the performance requirements in ANSI/ISA-S92.04.01, Part I, *Performance Requirement for Instruments Used to Detect Oxygen-Deficient/Oxygen-Enriched Atmospheres*.

1.2 Definitions of terms, as used herein, are referenced in Clause 3 of ANSI/ISA-S92.04.01, Part I.

1.3 References useful in the installation, operation, and maintenance of oxygen detection instruments are listed in Annex C. These references are not considered to be part of this document, except for those specific clauses of documents referenced elsewhere in this Recommended Practice.

2 Purpose

This Recommended Practice establishes user criteria for the installation, operation, and maintenance of instruments used to detect oxygen-deficient/oxygen-enriched atmospheres.

Its companion Standard, ANSI/ISA-S92.04.01, Part I, provides minimum requirements for the performance of instruments used to detect oxygen-deficient/oxygen-enriched atmospheres.

3 General requirements

3.1 The following general requirements are intended to ensure that the instrument is suitable for the intended application and is compatible with its operating environment:

a) The user should provide the potential supplier with detailed information on the conditions that exist in the area(s) in which the instrument is to be used;

b) The instrument must meet the requirements of the applicable authority having jurisdiction; and

c) The instrument must be compatible with the environmental conditions; e.g., relative humidity, temperature, altitude, and atmospheric contaminants, etc. in which the instrument is to operate. A typical "Environmental and Application Checklist," included as Annex A, is intended to aid users in properly specifying requirements for their specific applications.

4 Unpacking

4.1 Unpack the shipping carton(s) and determine whether the order is complete "as received." Check for main assembly, accessories, spare parts, and instruction manual.

4.2 In the event of shipment damage or for purposes of future correspondence, record the following:

a) User's purchase order number and manufacturer's order number and their respective dates

b) Carrier waybill number and date received in case of transit claim

c) Instrument serial number and user identification (ID) number, if assigned

5 Storage

5.1 When storing oxygen detection instruments, leave the instruments in their original containers or provide suitable protective covers.

5.2 Select a storage location that is in accordance with the manufacturer's recommendations. The environmental conditions (temperature, humidity, etc.) should comply with the manufacturer's storage specifications.

5.3 Before storage, inspect the instruments and remove any internal batteries and sensors that could cause corrosion, as directed by the manufacturer’s instructions. If the instruments have rechargeable or "permanent" batteries, consult the manufacturer's instructions for battery maintenance during this period.

6 User record keeping

6.1 It is recommended that users

a) assign an equipment identification (control) number to each instrument; and

b) maintain complete records including periodic performance, calibration, and maintenance checks. (See Annex B.)

7 Maintenance

7.1 To maintain the reliability of oxygen detection instruments, it is recommended that users assign responsibility for their initial inspection and subsequent use, including maintenance, to a specific qualified individual or group.

7.2 It is important that the checkout procedures (see Clause 10) be performed by qualified personnel who are trained in the operation, maintenance, and repair of instruments, and that the group responsible for maintenance be defined clearly.

7.3 It is recommended that users establish responsibility for obtaining the gas mixture recommended for calibration and testing by the instrument manufacturer.

7.4 It is recommended that when instruments are first put into use, the calibration be checked on a routine basis, as prescribed by the manufacturer. If experience shows minimal calibration deviation, then the period between calibration checks may be extended. Likewise, if routine checks indicate an increasing need for calibration, the period should be shortened and the cause should be investigated.

8 Preparing instruments for use

Read and understand the manufacturer-provided instruction manual. Pay particular attention to the location and functions of all controls and readout devices.

It is recommended that a shop calibration test of the type described in 13.7 be performed before the initial use of any oxygen-detecting instrument.

9 Installation of stationary instruments

It is extremely important that the equipment manufacturer-provided instruction manual be read thoroughly and followed completely.

9.1 Installation in hazardous (classified) locations

If instruments or ancillary components are installed in a hazardous (classified) location, they must be suitable for the area in which they are installed and so marked. Hazardous (classified) locations in the United States are defined by the *National Electrical Code®*, NFPA 70-1993, Articles 500-504. Markings required by ANSI/ISA-S92.04.01, Part I, should be visible to the operator. Installation of intrinsically safe systems shall be in accordance with ANSI/ISA-RP12.6, *Installation of Intrinsically Safe Systems for Hazardous (Classified) Environments*.

NOTE — Oxygen enrichment presents increased ignition risk, especially in a hazardous

(classified) location. This Recommended Practice should not be interpreted as suggesting that these instruments may be used routinely in hazardous locations in oxygen-enriched atmospheres.

9.2 Detector locations

While many factors are involved in detector-head quantity and location selection, industry standards and applicable regulations may dictate quantities and general or specific locations, and the following should be considered:

a) Air movement: Air velocity, and temperature influence the dispersion of vapors/gases to be monitored.

b) Ambient temperature (see 9.8)

c) Vibration (see 9.7)

d) Accessibility for future maintenance and calibration requirements

e) Structural arrangements (such as walls, troughs, or partitions), to avoid accumulation of gases

f) Mechanical damage and contamination: Detectors should be installed in locations that would preclude mechanical damage from normal operations (e.g., cranes, traffic, exhausts, and wash-downs).

g) Chemical damage and corrosion (e.g., corrosive gases and liquids, marine and industrial exposure)

h) Protection of personnel

i) Possible sources of electromagnetic interference/radio frequency interference (EMI/RFI)

j) Density and other characteristics of possible displacing gases, including humidity

9.3 Detector heads must be connected to their respective control units, as specified by the manufacturer (observing maximum loop resistance, minimum wire size, isolation, etc.). Interconnections must be made using cable, wire, and conduit or other system suitable for the purpose and the area classification.

9.4 Equipment required to be connected to ground in order to provide protection from electrical shock hazards shall be connected effectively with the general mass of the earth through a grounding system. The grounding system shall have sufficiently low impedance and shall have a current-carrying capacity sufficient at all times, under the most severe conditions that are likely to arise in practice, to prevent current in the grounding conductor from causing a potential of 30 V rms or 42.4 V peak to exist between accessible conductive parts of the equipment and adjacent accessible conductive surfaces within a 3.7 meter (12 ft.) radius. Where wet contact may occur, the maximum potential is reduced to 15 V rms or 21.2 V peak. This grounding system performance shall remain effective under all conditions.

9.5 To minimize electromagnetic interference (EMI), it is recommended that properly grounded, shielded, interconnecting cables (or wire and conduit) be used, and that enclosures (if of conductive material) be adequately grounded. It is recommended that cable shields be grounded at one point only: the controller end. It is recommended that splices in interconnecting sensor wiring be properly soldered (see 9.3).

9.6 If lubrication is used on threaded connections, it should be ascertained that the lubricant used contains no substance that might adversely affect the sensing elements or shielding.

9.7 All instruments and detector heads should be mounted in a manner to minimize vibration.

9.8 All detector heads and instruments should be mounted in areas that ensure compliance with the manufacturer's operating temperature specifications.

9.9 Adequate drainage should be incorporated into the system design to minimize moisture and condensation in the instrument, detector head, and interconnecting cable/conduit system.

9.10 Any potentially flammable or toxic gases introduced into sampling systems should be vented in a safe and appropriate manner.

9.11 When interconnecting ancillary devices, maximum current and voltage ratings of the instrument's outputs (e.g., interposing relay contacts) must be observed. These include barriers, isolation devices and other intrinsically safe and associated apparatus. (See NFPA 70, Article 504.)

10 Equipment checkout procedures

10.1 Portable instruments

10.1.1 With reference to and in accordance with the instruction manual, perform the following steps where applicable and necessary.

a) With the power OFF, reset the mechanical zero of any analog meters.

b) Ascertain that all electrical connections are properly tightened (remote detector head, power supply, etc.).

c) Check the battery voltage and battery condition, and make any required adjustments or battery replacements.

d) Check and replace clogged, dirty, broken, or damaged splash guards, filters, and flame arrestors.

e) With the power ON, allow adequate warm-up time.

f) For sample-draw instruments, check for sample-line leaks and proper flow.

g) Perform a test of the failure (malfunction) circuit(s).

10.1.2 Place the detector head (integral or remote) or the sample-draw assembly intake in an atmosphere of clean air, aspirate a large enough sample to purge the lines (applicable only to sample-draw instruments), and adjust the electrical output to indicate 20.9 percent of oxygen.

10.1.3 Check the response of the instrument using a known oxygen-air mixture, as recommended by the manufacturer, for the selected range concentration for which the instrument is intended to be used. If the test results are not within 5 percent full scale or 1 percent oxygen of the applied gas concentration, whichever is greater, recalibrate the instrument.

10.1.3.1 Test oxygen enrichment ranges with a test gas whose oxygen content is greater than the highest alarm set point. All alarms must actuate. Test oxygen-deficient ranges with a test gas whose oxygen content is less than the lowest set point. All alarms must actuate.

10.1.3.2 If an instrument fails this procedure, refer to the instruction manual and, if the suggested corrective action does not solve the problem, refer the instrument to the responsible maintenance individual or group.

10.2 Stationary instruments

10.2.1 With reference to and in accordance with the instruction manual, perform the following steps, when applicable and necessary:

a) With the power OFF, reset the mechanical zero of any analog meters.

b) Ascertain that all electrical connections are properly tightened (remote detector head, power supply, etc.).

c) Verify that all explosionproof enclosures are provided with the correct number of proper bolts/fasteners and all required conduit/cable seal fittings. Verify that bolts/fasteners are tightened/secured to specifications and that seal fittings are properly poured.

d) Apply power to the system and verify that all indicators operate properly.

e) Allow the system to warm-up for an adequate time to achieve stability of reading.

10.2.2 With the detector head in an atmosphere of clean air, verify proper operation of all alarm set points, using the "calibrate" control (or other methods recommended by the manufacturer) to offset the display up or down scale. Before proceeding, reset the meter to 20.9 percent if it was moved.

10.2.3 Check the response of the instrument using a known oxygen mixture (as recommended by the manufacturer) for the selected range concentration for which the instrument is intended to be used. If the test results are not within 5 percent of full scale or 1 percent oxygen of the applied test gas, whichever is greater, recalibrate the instrument as recommended by the manufacturer.

10.2.4 If an instrument fails this requirement after reference to the instruction manual and if the suggested corrective action does not solve the problem, refer the instruments to the responsible maintenance individual or group.

> **NOTE —** When calibrating for initial equipment checkout, consider possible contaminating, desensitizing, and interfering agents. (See 11.1[e], 11.2, and 6.2.1 of ANSI/ISA-S92.04.01, Part I.)

11 General considerations

11.1 Precautions

When using oxygen detectors, observe the following precautions (when applicable):

a) For sample-draw instruments, allow sufficient pumping time to draw the sample to the sensing element, and consider transport time. Long sample lines will introduce time delays in detection. Time delays should be determined, and sound engineering judgment should be applied to define acceptable limits for specific applications.

b) In areas where oxygen-displacing gases or vapors may not be uniformly mixed, perform checks at various elevations and locations.

c) When sampling-over liquids, ensure that the end of the sample line does not touch the liquid.

d) Ascertain the suitability of materials for sample lines. To avoid sampling losses, use only sample lines that are recommended by the manufacturer or known to the user as being compatible with the atmosphere.(Certain materials, although otherwise suitable for sample lines, may deteriorate from sunlight or other environmental conditions.)

e) Refer to the manufacturer's instruction manual for a listing of known interference gases. (Instruments within the scope of this Recommended Practice may not be specific to oxygen; that is, the presence of other (interference) gases may influence readings.)

f) Report erratic meter readings to the maintenance group. (Erratic readings typically indicate instrument malfunctions.)

g) Ascertain whether the sample flow to the sensor is clear. Steam, other vapors, aerosols, or other materials may coat tubing and fittings, impeding or blocking sample flow to the sensor.

h) Verify system operation whenever the control instrumentation is replaced, repaired, or modified.

i) Provide suitable instruments to detect toxic or flammable gases and vapors that may be present.

j) Recalibrate units after exposure to concentrations that exceed instrument range, unless stated otherwise by the manufacturer.

k) Calibrate units at the altitude at which it they are to be used.

11.2 Desensitizing agents

Some materials may have a poisoning, desensitizing, or inhibiting effect on some types of detectors, resulting in a loss of sensitivity. If desensitizing materials could be present in the atmosphere being monitored, check instrument sensitivity frequently, using a test gas mixture of known oxygen content. For some applications, it may be possible to detect oxygen in the presence of desensitizing agents; for such special applications, consult the manufacturer. Refer to the manufacturer's instruction manual for a listing of known desensitizing agents.

11.3 Entering atmospheres of potentially depleted/enriched oxygen

Any atmosphere that potentially contains less than or more than normal oxygen concentrations should be tested first from outside the area to establish safe levels before entry. In addition to testing for oxygen content, tests for toxicity and combustibility may be required to ensure personnel safety.

NOTE — Safe levels of oxygen concentration are determined by the authority having jurisdiction.

11.4 Use of appropriate accessories

Safety and accuracy of oxygen detection instruments may be improved in certain environments through the use of appropriate accessories. Install and use instruments in accordance with the manufacturer's instruction manual.

NOTE — Response time may be lengthened or accuracy affected by the use of such accessories.

a) If there is a danger of electrical shock while using a portable unit with a conductive sample probe, replace the conductive assembly with a non-conductive sample probe.

b) Ascertain whether a non-absorbent coarse filter is available for sampling in an atmosphere containing dust.

c) Ascertain whether a probe with a special tip or a liquid trap inserted in the sample line is available, in order to reduce the chance of liquids being ingested by instruments requiring a drawn sample.

d) Ascertain whether dilution assemblies are available, in order to permit the testing of atmospheres in which oxygen levels are above the normal range of the instrument.

e) Where long sample lines to the instrument are required, it may be desirable to install a sample valve or cock near the instrument to facilitate access to fresh air for "calibration" checks.

f) Accessories are often available and may be desirable for detectors installed in areas of high air velocity or liquid spray/wash-down.

g) Remote calibration accessories are often available and may be desirable for detector heads installed in locations difficult to access.

NOTE — For optimum accuracy, follow the manufacturer's recommendations for installation and calibration. Periodic physical inspections of detector heads and transport lines are recommended.

11.5 Electromagnetic interference (EMI)

Some oxygen detection instruments are susceptible to electromagnetic interference, especially radio frequency interference (RFI), which can cause malfunctions, false alarms, and zero drift. Where it is anticipated, select suitable apparatus that is resistant to such interference. (See 9.5.)

11.6 Maintenance schedule

Adopt a regular maintenance schedule that conforms to the manufacturer's instruction manual and the authority having jurisdiction. This maintenance schedule should be the responsibility of a designated and qualified individual or operating group. (See Annex B for recommended typical maintenance records.)

12 Operational check

Certain minimum operational checks are necessary during the use of the instrument. These checks should include

a) visual check

1) Check the instrument for abnormal conditions such as malfunctions, alarms, or unusual readings.

2) Assure that the detector head assembly is free of obstructions or coatings that could interfere with gas reaching the sensing element. Assure that the sample-draw rate is proper for sample-draw systems. See 13.4.

3) For sample-draw systems, inspect flow lines and fittings; cracked, pitted, bent, or otherwise damaged or deteriorated flow lines or fittings should be replaced with those recommended by the manufacturer.

b) response (sensitivity) check

Assure that the instrument indicates 20.9 percent when clean air is present. Temporarily supply the sensing element with clean air if necessary. When the reading is stable, adjust the instrument if necessary (according to the manufacturer's instruction manual).

1) Following the manufacturer's instructions, apply a known oxygen calibration gas to the detector head. If the reading is not within specifications, adjust or recalibrate according to the instruction manual (or return the instrument to the group or individual responsible for such adjustments/recalibrations).

2) For sample-draw systems, peridocially introduce calibration gas through transport lines and compare the results (accuracy and response time) to calibration results when the calibration gas is introduced directly to the sensor calibration port. This check is to verify that the transport lines, filters, etc., are not plugged or leaking. (See 13.4.)

3) Complete the maintenance records. (See Annex B for a typical maintenance record.)

4) If an instrument fails the visual or response check and if the suggested corrective action in the instruction manual does not solve the problem, refer the instrument to the maintenance group or individual responsible for repair.

13 Maintenance procedures

13.1 General

13.1.1 Maintenance procedures should be undertaken only by qualified personnel trained in the operation, maintenance, and repair of oxygen detection instruments.

13.1.2 If the maintenance facility is not adequately equipped or if qualified personnel are not available to perform the manufacturer's recommended checkout and maintenance procedures, users should contact the instrument manufacturer or other qualified outlet for repair. "Qualified" implies not only the ability to perform recommended procedures, but also knowledge and understanding of ANSI/ISA-S92.04.01, Part I; ISA-RP92.04.02, Part II; and the requirements of any applicable regulatory authority.

13.1.3 Complete and explicit instructions for testing and checkout of replaceable instrument components can be obtained from the manufacturer. Suitable parts lists and schematics are provided in the instruction manual.

13.1.4 After all defective operations are corrected in accordance with the instruction manual, a full shop-calibration test should be conducted. (See 13.7.)

13.2 Preliminary checkout

NOTE — Given the variety of instruments available, it is not practical for this Recommended Practice to tabulate each maintenance, repair, and calibration step in full detail. What follows is a listing of the principal items that all maintenance procedures should include.

13.2.1 If an instrument is in the shop for scheduled maintenance, the full maintenance procedure should be conducted. If specific instrument failure is a cause for return, the complaint should be noted, the instrument repaired, and applicable checkout tests conducted. All instruments, however, should undergo a full calibration test before being returned to service.

13.2.2 The instrument maintenance for the instrument should be reviewed for previous service history record. (See Annex B for a typical maintenance record.)

13.2.3 When a failed instrument is received, it should be determined if the instrument's power supply (including any voltage regulation stages and battery chargers supplied) is the primary cause for failure before proceeding further. An independent, commercially available, regulated, current-limited and filtered dc power supply should be used, where applicable, to

a) provide a constant source of dc voltage for instruments subject to battery drain during servicing; and

b) permit removal and isolation of the instrument's power supply for further testing, replacing, or recharging.

Detailed instructions for determining acceptable operation of the instrument's power supply may be obtained from the manufacturer.

13.2.4 After checking the power supply, repair personnel should proceed with the checkout of sensors, flow systems, readout devices, and alarm devices — identifying and correcting all deficiencies. The manufacturer's instructions should be followed when deciding whether to replace an assembly or repair it by replacing a component part. If components are replaced, the replacement components must meet the specifications and tolerances of the original components.

13.2.5 The following criteria should be considered for a scheduled maintenance procedure:

a) Instrument response should be tested with a known oxygen test mixture (air or oxygen-deficient/oxygen-enriched mixture); observe the readout, controls, switches, flow system, etc.

b) External potentiometric controls should be checked by rotating the shafts back and forth, feeling for variations in contact surfaces that might be a prelude to field failure.

c) Exterior housings should be examined for dents and distortions that could be a cause of nonfunctional readouts or intermittent electrical operation.

d) Circuit boards and wiring should be visually examined for burns, cracks, improper solder joint conditions e.g., cold solder joints, and inadequate conformal coating. All wir-

ing should be checked for shorting, improper termination, and poor connection integrity.

e) Fuses (current and voltage ratings, and continuity) and fuse holders should be checked and replaced, as necessary.

13.3 Detector head

13.3.1 Depending on the time interval since the last sensing element replacement, anticipated field usage, and response to the gas mixture during calibration, good maintenance practice suggests automatic sensing element evaluation/replacement at service intervals recommended by the manufacturer. Detector heads must be calibrated and evaluated in accordance with the manufacturer's instructions. Sensing elements must be replaced if the instrument cannot be adjusted to read a known oxygen content or if the readout is erratic.

13.3.2 If filters, traps, flame arrestors, or housings are part of the detector head assembly, they should be checked for proper attachment, function, fit, signs of corrosion, dirt, and moisture. Any necessary cleaning or replacement should be in accordance with the manufacturer's instructions.

13.4 Flow system

13.4.1 This clause is applicable only to those instruments utilizing aspirated sampling.

13.4.2 The flow system must be checked for leakage, restrictions, and proper pump operation. Any necessary cleaning, repair, or replacement should be in accordance with the manufacturer's instructions.

13.4.3 All filters, traps, and flame-arresting assemblies should be emptied, cleaned, or replaced in accordance with the manufacturer's instructions.

13.4.4 The flow system and sample chamber should be examined for deposits of foreign material, and steps taken to prevent future accumulations.

13.4.5 All flow connections should be tightened in accordance with the manufacturer's instructions.

13.4.6 All valves and moving pump parts should be lubricated, but only in accordance with the manufacturer's recommendations.

13.4.7 Sample-draw systems should be adjusted to the correct flow rate, using recommended test instruments.

13.4.8 The trouble signals for loss of flow, as required in ANSI/ISA-S92.04.01, Part I, 5.4.2, should be checked for proper operation.

13.5 Readout devices

13.5.1 If the instrument incorporates a meter, perform the following procedures:

a) Inspect the meter for broken or cracked lens.

b) Inspect analog meters for defects (bent pointers, loose dials, loose up-scale and down-scale stops, etc.)

c) Inspect digital meters for defects (e.g., segments, backlights, etc.)

d) Conduct other electrical and mechanical meter tests that the instrument manufacturer deems necessary to assure proper performance.

13.5.2 If auxiliary outputs (e.g., readouts, alarms, etc.) are incorporated, they should be tested according to the manufacturer's instructions.

13.6 Alarms

Check all alarms for proper alarm operation by offsetting the span (or by other methods, as recommended by the manufacturer) until the alarm(s) is actuated. Check failure (malfunction) circuits by disconnecting components (or other actions recommended by the manufacturer) and observing whether or not the failure alarm is actuated. Restore the instrument to its original condition after checking the alarms.

13.7 Shop calibration test

13.7.1 The instrument should be calibrated in accordance with this Recommended Practice, using the manufacturer's recommended calibration equipment and specified calibration procedure. A known oxygen "calibration mixture," preferably near mid-range, in sufficient quantity and accuracy for shop use, can be purchased commercially. All "calibration mixtures" and associated calibration apparatus should have the following characteristics to ensure reliable results:

a) Calibration mixtures should be certified or analyzed to be accurate to within 2 percent full scale or 0.5 percent oxygen of the actual labeled concentration, whichever is greater.

b) A regulator assembly of sufficient sensitivity and stability should be used to reduce compressed cylinder pressures. The regulator should be suitable for this service and incorporate appropriate connections.

c) A direct-reading flowrate indicator, preset regulator, expandable bladder, or other flow-controlling element should be installed in the calibration mixture supply line to permit adjustment of flow rate to the instrument manufacturer's specified value or range and accuracy.

d) All calibration system components should be resistant to corrosion by the calibration mixture.

13.7.2 For the calibration test, the mixture of gas recommended by the instrument manufacturer (and for which the instrument is factory calibrated) should be used.

13.7.3 All tests should be conducted in a manner to ensure safe venting of calibration mixtures.

13.7.4 Instruments should be allowed to stabilize at operating temperature. Then, operating controls should be adjusted in accordance with the instruction manual.

13.7.5 The calibration system should be connected to the instrument and the stabilized reading noted. The calibration span (gain) potentiometer should be adjusted, if necessary, so the output reading equals the content of the calibration mixture. This may include setting a zero point with or without the use of an oxygen-free calibration mixture per the recommendation of the manufacturer. The calibration mixture should be removed, and it should be ascertained that the instrument returns to "air reading." This procedure may require repeating.

13.7.6 It should be ascertained that all alarms are actuated when the set point(s) is reached, following the manufacturer's recommendations.

13.7.7 The calibration test as herein described should be the last test conducted before an instrument is released from the shop. It is recommended that the calibration data be recorded in the maintenance records. (See Annex B for a typical maintenance record.) The maintenance record (or comparable document) should be updated before returning the instrument to service.

14 External power supply systems

14.1 General

Stationary systems require reliable external power supply systems, either ac or dc. A dc system may be preferred in some applications for reasons given below. Whether an ac or dc supply is required depends on the specific instrument utilized.

Any peripheral external power supply equipment provided must be suitable and approved for the area where it is to be used both for environmental conditions and for the area classification.

14.2 AC supplies

14.2.1 When reliable ac power is available, units are often furnished ac power directly. When continuous power is required, however, the ac supply usually is provided with a battery charger/ inverter system. In such a system, the inverter provides standby power from batteries in the event of failure of the normal power source.

14.2.2 For most installations where standby power is required, It is recommended that dc-powered equipment be utilized directly.

14.3 DC supplies

14.3.1 It usually is desirable to utilize external dc supplies for one or more of the conditions discussed below.

14.3.2 It generally is recommended (and frequently required) that electrical controls for safety systems such as gas detector systems be installed "normally energized" ("fail safe"). This means that power is supplied continuously during normal operations to devices (such as solenoid valves) that provide equipment shutdown or other "corrective action" if gas concentrations corresponding to specific alarm set point(s) are reached. Under these conditions, interruption of power due to either deliberate safety device actuation or accidental loss of power will initiate equipment shutdown (or other "corrective action"). If continuous power is not supplied, nuisance shutdowns will result from even momentary power disruptions. Special consideration should be given to systems where unwarranted shutdowns (such as those caused by coil failure of an energized solenoid valve) could create potentially hazardous situations.

14.3.3 It is desirable to provide a means that will allow the system to be tested (and calibrated) without initiating equipment shutdown (or other corrective action), but it should be evident to personnel that the system is in the test (bypass) mode.

14.3.4 It may be desirable to provide a battery or battery charger status output to allow the installation of a remote trouble signal.

14.3.5 DC power systems often are desirable to serve as buffers between ac power sources and gas detection systems to reduce the instruments' exposure to transients and short periods of time when ac power is off-voltage or off-frequency.

14.3.6 Normally, it is desirable (and frequently required) that oxygen-detection systems remain operative for limited periods of time when ac power is not available. This feature is particularly attractive for systems installed at locations that are unmanned, remote, or subject to frequent ac power failures. It is even more important if controls are installed normally energized (fail safe).

In addition to conventional ac-powered battery charger systems, users may wish to consider photovoltaic cells, thermoelectric generators, and other non-conventional power sources. Environmental conditions (temperature, availability of sunlight, etc.) are influencing factors in choosing alternate power sources.

Annex A — Environmental and application checklist for oxygen-deficient/oxygen-enriched (typical)

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

a) Briefly describe the application in which the instrument is to be used (address: sampling methods, special environments, and locations).

b) If monitored points are separate from the control unit, what distances are involved?

c) List toxic, combustible, and asphyxiating gases and/or vapors that may be present and their approximate sample composition.

Gas or Vapor Component *	Concentration	Special Considerations

* Also list chemical name, if possible.

If toxic, combustible, or asphyxiant gases are anticipated, indicate whether these gases or vapors will be present *separately* or *in combination*.

d) Estimated oxygen range of atmosphere to be sampled.

e) Required instrument measuring range(s):

f) Ambient temperature range in which the control unit is to be used:

_____°C minimum to _____°C maximum.

Average expected temperature: _____°C

g) Ambient temperature range in which the detector head is to be used:

_____°C minimum to _____°C maximum.

Average expected temperature: _____°C

h) Ambient humidity range of atmosphere to be monitored:

_____% RH minimum to _____ % RH maximum.

i) Pressure range of atmosphere to be monitored:

_____ kPa(psia) minimum to _____ kPa(psia) maximum.

j) Velocity range of atmosphere to be monitored:

_____ m/sec(ft/sec) minimum to _____ m/sec(ft/sec) maximum.

k) Other pertinent conditions (presence of dusts, corrosives, fumes, mists, EMI/RFI, etc.). Please state type and amount, if possible.

l) Potential desensitizing agents or other materials that can affect instrument performance:

m) Classification of the location in which the control unit is to be used:

Class:_____ Division:_____ Group:_____

Classification of the location in which the detector head is to be used:

Class:_____ Division:_____ Group:_____

n) Will electrical shock hazards exist in the vicinity to be tested for combustibles (requiring a non-conducting probe)?

o) Additional accessories required:

Annex B — Instrument maintenance record for oxygen-deficient/oxygen-enriched detectors (typical)

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

Manufacturer _____ Model No. _____

Date Purchased _____ Date Placed in Service _____

Serial No. _____ User ID No _____

Calibration Gas Oxygen Content _____ Location _____

Source of Calibration Gas:

Maintenance other than routine calibration

Date	Check One		Returned by	Serviced by	Nature of service and parts replaced [1]
	Scheduled Maintenance	Failure			

[1]Include modifications, adjustments, etc.

Calibration record

Date	Comments [2]

[2]Include calibration difficulties, reading, and percent or pressure of oxygen applied prior to calibration, etc.

Annex C — References

This annex is included for information only and is not a part of the Recommended Practice.

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices -1992-1993 (or latest revision)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z88.2 Practices for Respiratory Protection, 1980

Available from: **ANSI**
11 West 42nd Street
New York, NY 10036 Tel: (212) 642-4900

AMERICAN PETROLEUM INSTITUTE (API)

API RP 14F Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms, 1991

API RP 500 Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities, 1991

API RP 2015 Safe Entry and Cleaning of Petroleum Storage Tanks, 1991

Available from: **API**
1220 L Street, N.W.
Washington, DC 20005 Tel: (202) 682-8357

BRITISH STANDARDS INSTITUTE (BSI)

BS.5345 Parts 1 – 9	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)

Available from: BSI
Linwood Wood
Milton Keynes
MK 146LE
ENGLAND Tel: 44 908 220022

CANADIAN STANDARDS ASSOCIATION (CSA)

C22.2 No. 0.4	Bonding and Grounding of Electrical Equipment (Protective Grounding)
C22.2 No. 152	Combustion Gas Detection Instruments

Available from: **CSI**
178 Rexdale Boulevard
Etobicoke, Ontario M9W 1R3
CANADA Tel: (416) 747-4044

FACTORY MUTUAL RESEARCH CORPORATION (FMRC)

Class No. 3610-1988	Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations
Class No. 3611-1986	Electrical Equipment for Use in Class 1, Division 2, Class II, Division 2, and Class III, Division 1 and 2 Hazardous (Classified) Locations
Class No. 3615-1989	Explosion Proof Electrical Equipment General Requirements
Class No. 3600-1989	Electrical Equipment for Use in Hazardous (Classified) Locations General Requirements
Class No. 6310, 6320-1989	Combustible Gas Detectors

Available from: **FMRC**
1151 Boston-Providence Turnpike
Norwood, MA 02062 Tel: (617) 762-4300

INSTITUTE OF ELECTRICAL AND ELECTRONICS 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**
PO Box 1331
445 Hoes Lane
Piscataway, NJ 08855-1331 Tel: (800) 678-4333

ISA

S5.1-1992	Instrumentation Symbols and Identification
S12.1-1991	Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations
S12.4-1970	Instrument Purging for Reduction of Hazardous Area Classification
RP12.6-1987	Recommended Practice for Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
S12.13-1986	Part I, Performance Requirements, Combustible Gas Detection Instruments
RP12.13-1986	Part II, Installation, Operation, and Maintenance of Combustible Gas Detection Instruments
S12.15-1991	Part I, Performance Requirements, Hydrogen Sulfide Detection Instruments
RP12.15-1991	Part II, Operation and Maintenance of Hydrogen Sulfide Detection Instruments
S51.1-1993	Process Instrumentation Terminology
S71.04-1986	Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants
S82.01-1994	Safety Standard for Electrical and Electronic Test, Measuring, and Controlling and Related Equipment – General Requirements
ANSI/ISA-S82.02.02-1996	Safety Standard for Electrical and Electronic Test, Measuring, and Controlling and Related Equipment – Electrical and Electronic Test and Measuring Equipment

S82.03-1988 Safety Standard for Electrical and Electronic Test, Measuring, and Controlling and Related Equipment – Electrical and Electronic Process Measurement and Control Equipment

Available from: **ISA**
PO Box 12277
67 Alexander Drive
Research Triangle Park, NC 27709 Tel: (919) 549-8411

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

Pub. 654-1-1979 Operating Conditions for Industrial-Process Measurement and Control Equipment, Part I: Temperature, Humidity and Barometric Pressure

Available from: **IEC**
3 Rue de Varembe
PO Box 131
Geneva 20, CH-1211
Switzerland Tel: 41 22 7340150

NATIONAL ASSOCIATION OF CORROSION ENGINEERS (NACE)

Corrosion Data Survey, Metals Section

Available from: **NACE**
PO Box 218340
1440 S. Creek Drive
Houston, TX 77218-8340 Tel: (713) 492-0535

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA No. 1-1992 National Fire Prevention Code, Section 12/Chapter 3, Oxygen-Enriched Atmospheres

NFPA No. 70-1993 *National Electrical Code®*

NFPA No. 306-1993 Control of Gas Hazards on Vessels

NFPA No. 496-1993 Purged and Pressurized Enclosures for Electrical Equipment

Available from: **NFPA**
PO Box 9101
One Batterymarch Park
Quincy, MA 02269-9101 Tel: (617) 770-3000

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

Pub No. 80-106	Criteria for Working in Confined Spaces
Pub. No. 87-113	Guide to Safety in Confined Spaces
Pub. No. 87-116	Technical Guide to Industrial Respiratory Protection

Available from: **NIOSH**
4676 Columbia Pkwy.
MS C-21
Cincinnati, OH 45226-1998 Tel: (800) 35-NIOSH

UNDERWRITERS LABORATORIES, INC. (UL)

UL 913-1988	Intrinsically Safe Apparatus and Associated Apparatus for Use In Class I, II, and III, Division 1, Hazardous (Classified) Locations

Available from: **UL**
333 Pfingsten Road
Northbrook, IL 60062 Tel: (708) 272-8800

UNITED STATES COAST GUARD (USCG)

Title 46	Subchapter D-Tank Vessels, Part 35-Operations
Title 46	Subchapter O-Certain Bulk Dangerous Cargoes, Part 153 Safety Rules for Self-Propelled Vessels Carrying Hazardous Liquids, Subpart C-Operations (General Vessel Safety)

Available from: **U.S. Government Printing Office**
Superintendent of Documents
Washington, D.C. 20402

UNITED STATES CODE OF FEDERAL REGULATIONS

Title 29, Part 1910	Occupational Safety and Health Standards, Subpart S, Electrical
Title 29, Part 1915	Occupational Safety and Health Standards for Shipyard Employment, Subpart B, Explosive and Other Dangerous Atmospheres

Available from: **U.S. Government Printing Office**
Superintendent of Documents
Washington, D.C. 20402

MISCELLANEOUS

Handbook of Chemistry and Physics. 76 Edition, 1995-96. R. C. Weast, Editor. CRC Press, Inc., Boca Raton, Florida

Available from: **Chemical Rubber Publishing Company (CRC)**
2000 Corporate Blvd. NW
Boca Raton, FL 33431 Tel: (407) 994-0555 (407) 994-0555

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