

Australian/New Zealand Standard™

**Electrical equipment for detection of
oxygen and other gases and vapours at
toxic levels—General requirements and
test methods**



AS/NZS 4641:2018

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Australian Chamber of Commerce and Industry
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Construction, Forestry, Maritime, Mining and Energy Union
Department of Mines, Industry Regulation and Safety (WA)
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Australian/New Zealand Standard™

Electrical equipment for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-023, Electrical equipment in mines and quarries, to supersede AS/NZS 4641:2007.

The objective of this Standard is to provide general requirements and test methods for manufacturers, testing authorities and certifying bodies concerned with electrical equipment for the measurement of the concentration of oxygen and toxic levels of gases and vapours.

The principal differences between this edition and the 2007 edition are as follows:

- (a) The nomenclature 'equipment' has replaced 'apparatus' but with the same meaning.
- (b) Requirements have been revised to enhance consistency with the principles of IEC 60079.29.1:2016.
- (c) The requirements for vibration testing have been expanded to discriminate between portable and machine-mounted equipment, and fixed and transportable equipment.
- (d) Requirements for software documentation have been simplified.
- (e) The requirements for fast transient testing have been relaxed for equipment intended for exclusive use in intrinsically safe applications.
- (f) Requirements for testing for electromagnetic immunity have been revised to enable testing for specific applications.
- (g) Appendix A has been added to describe tests to be completed on software/firmware revision.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electrical equipment for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard applies to gas detection equipment, including explosion-protected gas detection equipment, used to measure the concentration of oxygen and toxic levels of gases and vapours. This Standard also applies to those parts of multi-gas detection equipment which are used to measure the concentration of oxygen and toxic levels of gases and vapours.

This Standard does not apply to gas detection equipment, or those parts of multi-gas detection equipment, used to detect flammable gases and vapours below, within and above their flammability limits. Such equipment is covered by AS/NZS 60079.29.1.

NOTE: Equipment that is within the scope of this Standard and AS/NZS 60079.29.1 may be assessed and tested to both Standards.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS/NZS

60079 Explosive atmospheres

60079.0 Part 0: Equipment—General requirements

60079.20.1 Part 20.1: Material characteristics for gas and vapour classification—Test methods and data

60079.29.1 Part 29.1: Gas detectors—Performance requirements of detectors for flammable gases

61000 Electromagnetic compatibility (EMC)

61000.4.1 Part 4.1: Testing and measurement techniques—Overview of IEC 61000-4 series

61000.4.3 Part 4.3: Testing and measurement techniques—Radiated radio frequency electromagnetic field immunity test

61000.4.4 Part 4.4: Testing and measurement techniques—Electrical fast transient/burst immunity test

Australian Safety and Compensation Council*

Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:1003 (1995)]

Guidance Note on the Interpretation of Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:3008 (1995)]

Occupational Safety and Health Service Department of Labour, New Zealand
Workplace Exposure Standards†

* Refer to <http://www.safeworkaustralia.gov.au>.

† Refer to <http://www.business.govt.nz/worksafe>.

1.3 DEFINITIONS

For the purpose of this Standard the definitions below apply.

NOTE: For other definitions, AS/NZS 60079.0 and AS/NZS 60079.29.1 may be taken for guidance.

1.3.1 Gas properties

1.3.1.1 *Ambient temperature*

Temperature of the normal atmosphere surrounding the equipment.

1.3.1.2 *Clean air*

Air that is free of flammable or toxic gases, and interfering or contaminating substances.

1.3.1.3 *Concentration*

The amount of the gas or vapour of interest in a specified amount of the background gas or air, expressed in suitable units.

NOTE: Typical units include volume fraction (v/v) (see Clause 1.3.1.14); molar (moles per mole – m/m); percentage of the lower flammable limit (LFL) of a particular substance; parts per million by volume (ppm); parts per billion by volume (ppb).

1.3.1.4 *Explosive gas atmosphere*

Mixture of flammable gases or vapours, with air, which after ignition in normal atmospheric conditions, permits self-sustaining flame propagation.

NOTES:

- 1 This definition specifically excludes dusts and fibres in suspension in air. Mists are not covered by this Standard.
- 2 Although a mixture that has concentration above upper flammable limit is not an explosive atmosphere, in certain cases it is advisable to consider it as an explosive gas atmosphere.
- 3 Normal atmospheric conditions include variations above and below the reference levels of 101.3 kPa and 20°C provided that the variations have a negligible effect on the explosive properties of the flammable materials.

1.3.1.5 *Flammable gas*

Gas or vapour which, when mixed with air in a certain proportion, will form an explosive atmosphere.

NOTE: For the purpose of this Standard the term ‘flammable gas’ includes flammable vapours.

1.3.1.6 *Functional check*

Application of test gas to the monitor to check the response signal or the generation of an alarm, without adjustments of zero, sensitivity, or alarm level.

1.3.1.7 *Lower flammable limit (LFL)*

Volume fraction of flammable gas or vapour in air below which an explosive gas atmosphere does not form, expressed as a percentage (refer to AS/NZS 60079.20.1).

NOTE: This is also known as lower explosive limit (LEL).

1.3.1.8 *Poisons (of monitors)*

Substances which lead to temporary or permanent loss of sensitivity of the monitors.

1.3.1.9 *Potentially explosive atmosphere*

Atmosphere that could become explosive (the danger is a potential one).

NOTE: Apart from an atmosphere below the lower flammable limit (LFL), this could include an atmosphere currently above the upper flammable limit (UFL), where dilution with air would render it explosive.

1.3.1.10 *Time-weighted average (TWA)*

The average airborne concentration of a particular substance when calculated over a normal eight-hour working day.

1.3.1.11 *Toxic gas or vapour*

General term for any gas or vapour that is harmful to human health.

NOTE: For the purposes of this Standard, the word 'toxic' should be taken to include 'very toxic', 'toxic', 'harmful', 'corrosive', 'irritating', 'sensitizing', 'carcinogenic', 'mutagenic', 'teratogenic'.

1.3.1.12 *Upper flammable limit (UFL)*

Volume fraction of flammable gas or vapour in air above which an explosive gas atmosphere does not form, expressed as a percentage (refer to AS/NZS 60079.20).

NOTE: This is also known as upper explosive limit (UEL).

1.3.1.13 *Volume fraction (v/v)*

Ratio of the volume of a component gas to the volume of the gas mixture under specified conditions of temperature and pressure.

1.3.2 *Miscellaneous*

1.3.2.1 *Cross sensitivity*

The output signal produced by the equipment due to a known concentration of the target gas or vapour, relative to the signal produced by the same concentration of any other gas or vapour.

NOTE: This is also known as selectivity.

1.3.2.2 *Nominal supply voltage*

Voltage that is given by manufacturers as the recommended operating voltage of their gas detection equipment.

1.3.2.3 *Sensitivity*

The output signal produced in the equipment by a known concentration of gas or vapour.

NOTE: Depending on context, this can refer to the minimum concentration of gas or vapour that the equipment will detect.

1.3.3 *Monitors*

1.3.3.1 *Monitor*

Assembly in which the sensing element is housed and which may also contain associated circuit components.

1.3.3.2 *Remote monitor*

Monitor that is not integral to the main body of the equipment.

1.3.4 *Sampling probe*

A device used to sample gas from a location spatially separated from the detector.

NOTE: A sampling probe is usually short (e.g. in the order of 1 m) and rigid or telescopic. It may be connected by a flexible tube to the equipment.

1.3.5 *Signals and alarms*

1.3.5.1 *Alarm set point*

Fixed or adjustable setting of the equipment that is intended to pre-set the level of concentration at which the equipment will automatically initiate an indication, alarm or other output function.

1.3.5.2 Fault signal

Audible, visible or other type of output different from the alarm signal permitting, directly or indirectly, a warning or indication that the equipment is not working satisfactorily.

1.3.5.3 Latching alarm

Alarm that, once activated, requires deliberate action to be deactivated.

1.3.6 Special state

All states of the equipment other than those in which monitoring of gas concentration take place, e.g. warm-up, calibration mode or fault condition.

1.3.7 Times

1.3.7.1 Final indication

Indication given by the equipment after stabilization.

1.3.7.2 Stabilization

State when three successive readings of an equipment, taken at two minute intervals, indicate no changes greater than $\pm 1\%$ of the measuring range.

1.3.7.3 Time of response $t(x)$

Time interval, with the equipment in a warmed-up condition, between the time when an instantaneous variation in volume fraction is produced at the equipment inlet and the time when the response reaches a stated percentage (x) of the final indication.

1.3.7.4 Warm-up time

Time interval, with the equipment in a stated atmosphere, between the time when the equipment is switched on and the time when the indication reaches and remains within the stated tolerances (see Figures 1.1 and 1.2).

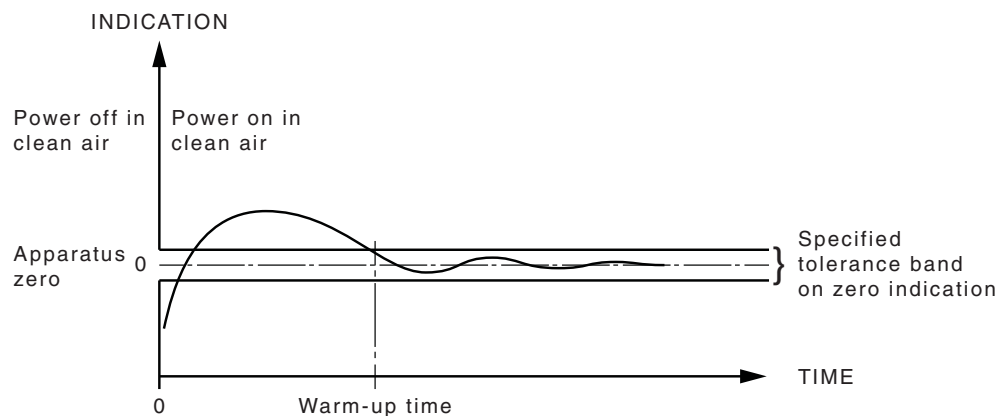


FIGURE 1.1 WARM-UP TIME IN CLEAN AIR (TYPICAL)

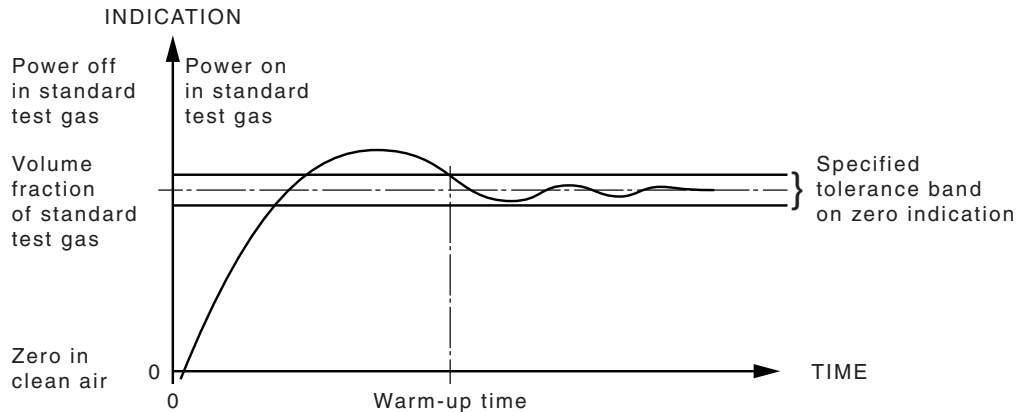


FIGURE 1.2 WARM-UP TIME IN STANDARD TEST GAS (TYPICAL)

1.3.8 Types of instruments

1.3.8.1 Alarm-only equipment

Equipment having an alarm but not having a meter or other indicating device.

1.3.8.2 Aspirated equipment

Equipment that obtains the gas by drawing it to the gas monitor, e.g. by means of a hand-operated or electric pump.

1.3.8.3 Continuous duty equipment

Equipment that is powered for long periods of time, but may have either continuous or intermittent sensing.

1.3.8.4 Fixed equipment

Equipment which is intended to have all parts permanently installed at a given location.

1.3.8.5 Group I equipment

Electrical equipment for mines susceptible to firedamp.

1.3.8.6 Group II equipment

Electrical equipment for places with a potentially explosive atmosphere, other than mines susceptible to firedamp.

1.3.8.7 Machine mounted equipment

Fixed equipment intended to be mounted on vehicles or stationary plant.

NOTES:

- 1 Machine mounted equipment differs from fixed equipment in that it may be subjected to vibration during use.
- 2 Machine mounted detectors are typically coupled to tripping devices to de-energize the machine in the presence of elevated levels of flammable gases.

1.3.8.8 Portable equipment

Continuous duty equipment that has been designed to be readily carried from place to place and to be used while it is being carried. A portable equipment is battery-powered and includes, but is not limited to—

- (a) a hand-held equipment, typically less than 1 kg, which requires use of only one hand in normal operation;

- (b) personal monitors, similar in size and mass to the hand-held equipment, that are continuously operating (but not necessarily continuously sensing) while they are attached to the user; and
- (c) larger equipment that can be operated by the user while it is carried either by hand, a shoulder strap or by a carrying harness; it may or may not have a hand-directed probe.

1.3.8.9 *Stand-alone control unit*

Fixed gas detection control units intended to provide meter indication, alarm functions and/or output contacts when utilized with stand-alone gas detection equipment.

1.3.8.10 *Stand-alone gas detection equipment*

Fixed gas detection equipment that provides a conditioned electronic signal or output indication to a generally accepted industry standard (such as 4–20 mA or 3–15 psi), intended to be utilized with stand-alone control units, or signal processing data acquisition, central monitoring and similar systems which typically process information from various locations and sources including, but not limited to, gas detection equipment.

1.3.8.11 *Transportable equipment*

Gas detection equipment designed to be routinely carried from place to place by a person or by machine.

NOTES:

- 1 A transportable detector is not expected to measure gas concentrations while being transported.
- 2 Transportable detectors do not include machine-mounted detectors that routinely measures gas concentrations while the machine is in operation.
- 3 Transportable detectors are typically used to provide coverage for a temporary work site before being relocated to another temporary work site.

SECTION 2 GENERAL REQUIREMENTS

2.1 INTRODUCTION

The equipment shall be in accordance with the requirements of this Standard. Where an equipment manufacturer makes any claims in the instruction manual regarding any special features of construction or superior performance that exceed these minimum requirements, all such claims shall be verified and the test procedures shall be extended or supplemented, where necessary, to verify the claimed performance.

The additional tests shall be identified and defined on the test reports.

NOTE: Additional tests to be performed may be agreed on between the manufacturer and the test laboratory.

Electrical assemblies and components shall be in accordance with the construction and test requirements of Clause 2.2, where applicable. Generally, equipment tested to this Standard would be expected to be explosion-protected and be in accordance with the requirements of Group I or Group II or both, depending on application. Where an instrument is not explosion-protected, the criteria for tests in this Standard shall be those applicable to Group II if there is a distinction.

NOTE: As many types of gas detection equipment use toxic and oxygen sensors in combination with combustible gas sensors, the requirements in this section of the Standard have been closely aligned with Section 4 of IEC 60079-29-1:2016, *Explosive atmospheres—Part 29-1: Gas detectors—Performance requirements of detectors for flammable gases*.

2.2 CONSTRUCTION

2.2.1 General

Gas detection equipment or parts thereof (e.g. remote sensors) specifically intended for use in the presence of corrosive vapours or gases, or which may produce corrosive by-products as a result of the detection process (e.g. catalytic oxidation or other chemical process) shall be constructed of materials known to be resistant to corrosion by such substances.

All equipment shall be constructed to facilitate regular functional checks.

All materials and components used in the construction of the equipment shall be used within the manufacturer's ratings or limitations, unless otherwise specified by appropriate safety standards.

Any malfunction of outputs from the gas detection equipment not relevant to safety or health shall not adversely affect the functions of the equipment related to safety.

Example: Equipment with 4-20 mA and highway addressable remote transducer (HART) communication where only the 4-20 mA communication is defined in the instruction manual as related to safety. The loss of HART communication is not related to safety.

2.2.2 Indicating devices

2.2.2.1 General

Readily distinguishable indications shall be provided to show that the equipment is energized, in alarm or in special states.

Portable equipment shall provide visual and audible indications for both fault and alarms.

If audible indications are provided for transportable or fixed equipment, alarms shall be indicated as a minimum.

All methods of indication of the measured value shall present the same value within the resolution of each indicator.

The indications related to gas detection transmitters and remote sensors for fixed equipment may be shown only at the (separate) gas detection control unit.

2.2.2.2 Resolution

For alarm-only equipment or equipment where the resolution of the read-out device is inadequate to demonstrate conformance with this Standard, suitable points for connecting, indicating or recording devices for the purpose of testing shall be identified.

The indication on the readout device shall not contradict the results obtained by additional indicating or recording devices.

2.2.2.3 Measurement range

Any under-range or over-range measurements shall be clearly indicated and signalled to remote equipment where remote signalling is used.

2.2.2.4 Selectable range

If the equipment has more than one measuring range, the range selected shall be clearly identified.

2.2.2.5 Suppression of indication and measured values below zero

It shall be possible to configure the equipment such that when in measuring mode any suppression of the measured value is permanently disabled.

When in calibration mode any suppression of the measured value shall be automatically disabled.

Measured values below the lower limit of measurement specified in the instruction manual shall be indicated as one of the following:

- (a) Zero.
- (b) The measured value.
- (c) An indication that the measured value is below the lower limit of measurement.

Measured values below minus twice the lower limit of measurement shall be indicated as one of the following:

- (i) The measured value.
- (ii) A fault signal.

Measured values below minus four times the lower limit of measurement shall be indicated by a fault signal.

Any suppression of indication shall be explained in the instruction manual [see Clause 2.4 (d)].

2.2.2.6 Indicating light

If only one indicating light is provided for signalling alarms, faults and other indications, it shall be coloured RED. If separate indicating lights are used or if a multi-coloured indicating light is provided, the colours shall be used in the following order of priority [(a) being the highest priority]:

- (a) Alarms indicating the presence of a gas concentration beyond an alarm set point shall be coloured RED.
- (b) Equipment fault indicators shall be coloured YELLOW.
- (c) Power supply indicators shall be coloured GREEN.

2.2.3 Alarm or output functions

Alarm devices shall not be adjustable to operate outside the measuring range.

If alarm devices, output contacts or alarm signal outputs are provided as part of fixed or continuous duty portable equipment and are intended to operate when a potentially hazardous gas concentration is detected, they shall be of a latching type requiring a deliberate manual action to reset.

NOTE: If two or more alarm set points having the same direction are provided (i.e. both increasing or both decreasing concentration), the first alarm may be non-latching—based on user preference.

Alarms shall remain in operation while the alarm condition is still present.

NOTE: An additional audible alarm may be silenced.

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 equipment, this shall include a contact or other transmittable output signal.

Alternatively, the output signal or contacts shall not be required if the alarms are automatically re-enabled within 15 min.

2.2.4 Fault signals

Fixed and transportable equipment shall provide a fault signal in the event of failure of power to the equipment.

Externally powered equipment shall provide a fault signal when the power supply falls below the manufacturer's specified minimum supply voltage fault limit.

A short-circuit or open-circuit in connections to any remote sensor shall be indicated by a fault signal.

NOTE: Under the above conditions the equipment may also indicate alarm.

Measured values below zero (e.g. caused by drift) shall be indicated by a fault signal in accordance with the conditions of Clause 2.2.2.5.

For equipment where the sensor can be disconnected without opening the housing, the equipment shall provide a fault signal in the event of a disconnection of the sensor.

Automatically aspirated equipment shall be provided with an integral flow indicating device that produces a fault signal in the event of low flow.

2.2.5 Adjustments

All adjustment devices shall be designed so as to prevent unauthorized or inadvertent interference with the equipment. Fixed explosion protected equipment housed in explosion protected enclosures shall be designed so that, if any facilities for adjustment are necessary for routine recalibration and for resetting or like functions, these facilities shall be externally accessible.

The means for making adjustments shall not degrade the explosion protection of the equipment.

The adjustments of the zero and signal amplification shall be so designed that—

- (a) adjustment of one will not affect the other; or
- (b) it shall not be possible to adjust only one and the sequence of adjustments shall ensure that the affected one is adjusted second.

The equipment shall not perform an automatic zero adjustment during start-up. If equipment prompts the user for zero adjustment during start-up and the user makes no selection, equipment shall continue to start-up without zero adjustment, after a delay of no more than 15 s.

2.2.6 Battery-powered equipment

Equipment powered with integral batteries shall be provided with an indication of low battery condition, and the nature and purpose of this indication shall be explained in the instruction manual (see Clause 2.4).

2.2.7 Stand-alone gas detection equipment for use with separate control units

A specification shall be supplied with the equipment that describes the relationship between the detected target gas concentration and the corresponding output signal or indication (i.e. the equipment's transfer function). Such specification shall be detailed to the extent that the accuracy of this transfer function can be verified across the range of measurement. Full-scale output and status signals (e.g. fault, inhibit) shall also be specified.

Where necessary, equipment shall be provided to interpret the output signal or indication, which will enable the accuracy of the transfer function to be verified.

2.2.8 Separate control units for use with stand-alone gas detection equipment

A specification shall be supplied with the equipment that describes the relationship the input signal has with the calculated gas concentration (transfer function). Such specification shall be detailed to the extent that the accuracy of this transfer function can be verified across the range. Required inputs for full-scale indication and status signals (e.g. fault, inhibit) shall also be specified.

Where necessary, equipment shall be provided to provide the input signals, which will enable the accuracy of the transfer function to be verified.

2.2.9 Software-controlled equipment

2.2.9.1 General

In the event of software-controlled equipment experiencing hardware failure, or software entering undefined or uncontrolled states, the equipment shall fail-safe by entering into a pre-defined and documented special state. The special state shall be documented in the instruction manual.

2.2.9.2 Special state indication

If the equipment enters a special state this shall be indicated by a signal.

For fixed equipment, this shall include a contact or other transmittable output signal.

2.2.9.3 Software

Software components shall be in accordance with the following:

- (a) It shall be possible for the user to identify the installed version(s) of software by—
 - (i) marking(s) on the equipment visible without disassembly of the equipment; or
 - (ii) indication on the display for at least 3 s during power up or on user command.

NOTE: Appendix A lists the recommended performance testing to be undertaken when equipment software is revised.
- (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.
- (d) All user changeable parameters and their valid ranges shall be listed in the instruction manual.