

Australian/New Zealand Standard™

**Electrical equipment for coal mines—
Introduction, inspection and
maintenance**

**Part 3: Gas detecting and monitoring
equipment**



AS/NZS 2290.3:2018

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-023, Electrical Equipment in Mines and Quarries. It was approved on behalf of the Council of Standards Australia on 10 June 2018 and by the New Zealand Standards Approval Board on 4 July 2018.
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Australian/New Zealand Standard™

Electrical equipment for coal mines— Introduction, inspection and maintenance

Part 3: Gas detecting and monitoring equipment

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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 2290.3—1990, *Electrical equipment for coal mines—Maintenance and overhaul, Part 3: Maintenance of gas detecting and monitoring equipment*.

This Standard incorporates Amendment No. 1 (October 2019). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is Part 3 in a series of Standards on the maintenance and overhaul of electrical equipment used in association with coal mining. The series is as follows:

- (a) AS/NZS 2290.1, *Electrical equipment for coal mines—Introduction, inspection and maintenance, Part 1: For hazardous areas*.
- (b) AS/NZS 2290.3, *Electrical equipment for coal mines—Introduction, inspection and maintenance, Part 3: Gas detecting and monitoring equipment* (this Standard).

The objective of this Standard is to facilitate the safe, efficient and productive use of gas detection and monitoring equipment in coal mines, by specifying requirements and recommendations for the inspection and maintenance of such equipment.

The principal differences between this edition and the 1990 edition are as follows:

- (i) Equipment classifications have been revised to match common industry terminology.
- (ii) Accuracy requirements for gas detectors have been aligned with ‘as new’ design and performance requirements. (In the previous edition, accuracy requirements for maintenance were more onerous than for ‘new’ detectors.)
- (iii) Requirements for measuring the response time of detection systems have been introduced.
- (iv) Requirements for checking telemetry systems from gas detectors to alarm/tripping points have been added.
- (v) Requirements for maintenance of gas chromatographs have been added.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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FOREWORD

Gas detection and monitoring equipment form a critical safety system in coal mines. It is essential that—

- (a) the equipment is periodically inspected and maintained; and
- (b) the performance of the safety system (and individual sub-systems) are tested at regular intervals to verify performance.

The underlying principle of this Standard is that gas detection and monitoring equipment is maintained in ‘as new’ condition.

The ‘as new’ performance of portable and fixed detectors is described by:

- (i) AS/NZS 60079.29.1, *Explosive atmospheres, Part 29.1: Gas detectors—Performance requirements of detectors for flammable gases*, specifies general requirements for construction, testing and performance, and describes the test methods that apply to the detection and measurement of flammable gas or vapour concentrations with air.
- (ii) AS/NZS 4641, *Electrical apparatus for detection of oxygen and other gases and vapours at toxic levels—General requirements and test methods*, provides general requirements and test methods for manufacturers, testing authorities and certifying bodies concerned with electrical apparatus for the measurement of the concentration of oxygen and toxic levels of gases and vapours.

Tube bundle analysers and gas chromatograph systems do not have equivalent performance standards, and so greater reliance is made on manufacturers’ information for maintaining those systems. AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, provides general guidance on the competence to carry out tests and/or calibrations, including sampling, that are applicable to tube bundle analysers and gas chromatograph systems.

This Standard sets out a prescriptive approach to the inspection and maintenance requirements for gas detection and monitoring equipment used in mine safety systems. Minimum requirements are prescribed that are intended to be complemented by additional site-specific practices determined from risk analyses to ensure key safety system performance is reliably maintained.

This Standard is not intended to address equipment used to monitor, report or manage environmental emissions; however, the principles and practices described in this Standard may be used for guidance in such applications.

AS/NZS 60079.29.2, *Explosive atmospheres, Part 29.2: Gas detectors—Selection, installation, use and maintenance of detectors for flammable gases and oxygen*, provides guidance on, and recommended practice for, the selection, installation, safe use and maintenance of apparatus intended for the detection and measurement of flammable gases conform to the requirements of AS/NZS 60079.29.1, and so complements this Standard.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electrical equipment for coal mines—Introduction, inspection and maintenance****Part 3: Gas detecting and monitoring equipment**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out requirements for the inspection, maintenance and performance verification of gas detection and monitoring equipment that forms, or is a part of, a coal mine's safety system.

This Standard is applicable to the following:

- (a) Equipment that includes sensors to measure or monitor—
 - (i) Group I flammable gases at concentrations below, within, or above the explosive range;
 - (ii) toxic gases; and
 - (iii) oxygen.
- (b) Equipment that is—
 - (i) portable—handheld;
 - (ii) machine mounted;
 - (iii) fixed and transportable.
- (c) Equipment included in—
 - (i) tube bundle systems; and
 - (ii) gas chromatographic systems.

This Standard is not applicable to equipment used for monitoring or reporting of environmental emissions.

While this Standard addresses coal mine applications, the principles are also applicable to other mining applications where toxic gases may present operational hazards.

Section 2 describes the general requirements for inspection, maintenance and user servicing of gas detection and monitoring apparatus.

Section 3 sets out the schedule of inspections and tests applicable to various classifications of gas detection apparatus.

Section 4 describes the individual inspections and tests, the acceptance criteria, and the corrective actions applicable to portable handheld, machine mounted, fixed and transportable gas detectors.

Section 5 describes the individual inspections and tests, the acceptance criteria, and the corrective actions applicable to tube bundle and gas chromatograph systems.

Appendix A sets out the prescribed accuracies for various classes of gas detectors.

NOTE: Appendices B, C, D, E and F provide guidance on good practice for aspects of the installation, inspection and maintenance of gas detection and monitoring equipment.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS/NZS

4761 Competencies for working with electrical equipment for hazardous areas (EEHA) (series)

60079 Explosive atmospheres

60079.10.1 Part 10.1: Classification of areas—Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0 (2008) MOD)

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

AS ISO/IEC

17025 General requirements for the competence of testing and calibration laboratories

ISO/IEC

Guide 99 International vocabulary of metrology—Basic and general concepts and associated terms (VIM)

1.3 DEFINITIONS

For the purposes of this document, the following definitions apply.

1.3.1 Alarm

A visual or audible warning indication, tripping or other output function that is triggered by the detector measuring a pre-determined gas concentration threshold.

1.3.2 Alarm setpoint

Setting of the detector that determines the level of concentration at which the equipment will automatically trigger an alarm.

1.3.3 Authorized person

A person who is deemed competent having the knowledge, skills and experience, to effectively and safely carry out activities described in the Standard.

NOTE: AS/NZS 4761 offers guidance on competencies for working with portable and fixed gas detection equipment.

1.3.4 Calibration

Confirmation of linearity by measurement, and where necessary, adjustment, of a sensor's response across its full operating range to ensure maintenance of to a specified accuracy.

NOTES:

- 1 Calibration certificates are normally issued for this test.
- 2 The process also enables traceability to absolute SI reference units.
- 3 ISO/IEC Guide 99:2007 Clause 2.39 includes a more detailed definition for calibration.

1.3.5 Calibration certificate

Certificate issued by a calibration laboratory that performs the tests outlined in this Standard and meets the requirements of AS ISO/IEC 17025, specifying the equipment subjected to calibration, verifying that the equipment has been calibrated to the accuracy stated on, or referenced in, the certificate, and including the date of calibration and the identity/affiliation of the operator conducting the calibration.

NOTES:

- 1 The description of the equipment calibrated should differentiate between a sensor only, and any connecting cables, signal processing elements, logic solvers, actuators or telemetry systems that formed part of the equipment calibrated.

- 2 The format and content of the calibration certificate should conform to AS ISO/IEC 17025.
- 3 Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories may be able to offer accreditation against the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia and New Zealand, the National Association of Testing Authorities (NATA) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

1.3.6 Certified test gas

Mixture of a test gas and diluents, in which the true content of the test gas is known, with a confidence level and with a certificate from a laboratory or reference material producer that meets the requirements of AS ISO/IEC 17025 or AS ISO 17034 respectively.

NOTE: Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories (or reference material producers) may be able to offer accreditation against the requirements of AS ISO/IEC 17025 (or AS ISO 17034) respectively. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia and New Zealand, the National Association of Testing Authorities (NATA) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

1.3.7 Clean air

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

1.3.8 Concentration

The amount of target gas or vapour in a specified amount of background gas or air, expressed in stated units.

NOTE: Typical units include percent volume fraction (%v/v); molar (moles per mole—m/m); percentage of the LEL of a particular substance; parts per million by volume (ppm); parts per billion by volume (ppb).

1.3.9 Controller

The part of a gas detector that receives a signal from the sensor or sensor element and exercises logic to determine any subsequent actions in accordance with predetermined settings.

1.3.10 Drift

Variation with time in the detector's measured reading for a fixed concentration (including clean air) under constant ambient conditions.

1.3.11 Explosion protected equipment

Equipment incorporating a type of protection covered by the AS/NZS 60079 series.

1.3.12 Explosive gas atmosphere

Mixture of gas or vapour with air that, after ignition, permits self-sustaining flame propagation under normal atmospheric conditions.

NOTES:

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

1.3.13 Fixed (detector)

A gas detector that is installed and operated in one location for an appreciable period of time.

1.3.14 Flammable gas

Gas or vapour which, when mixed with air in critical proportions, will form an explosive gas atmosphere.

1.3.15 Gas chromatograph

A gas measurement device usually located in a dedicated facility or laboratory (such as on the surface of a mine) to provide accurate measurements of target gases using separation techniques.

NOTE: Gas samples can be delivered to the chromatograph using one or more sample delivery mechanisms.

1.3.16 Gas detector

Equipment for the detection, measuring and/or monitoring of flammable and toxic, gases and oxygen.

NOTES:

- 1 A gas detector typically consists of a sensor or sensing element, a logic solver to quantify measured gas concentration and compare with pre-set thresholds, and telemetry or actuation equipment to enable display and/or triggering of alarms.
- 2 The term 'gas detector' is sometimes abbreviated to simply 'detector' without loss of meaning.

1.3.17 Gas sample bag

A flexible container used for temporary storage of gas samples taken from point of sampling to the point of analysis.

NOTE: See Appendix B for guidance on sampling and testing applications.

1.3.18 Hazardous area (explosion risk zone)

Area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment.

NOTES:

- 1 Some legislation uses the terms 'hazardous zone' or 'explosion risk zone' to define geographical limits of the hazardous area.
- 2 AS/NZS 60079.10.1 provides comprehensive guidance on the classification of explosive gas atmospheres.

1.3.19 ILAC MRA

International Laboratory Accreditation Cooperation Mutual Recognition Arrangement.

1.3.20 Inspection

Careful scrutiny of an item carried out without dismantling, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of the item.

NOTE: The inspection should also extend to review of records associated with the equipment, including operating and fault logs, and maintenance history.

1.3.21 Latency

A time delay between initiation of an action and its execution, typically found in communication, monitoring and control systems.

1.3.22 Lower explosive limit (LEL)

Volume fraction of flammable gas in air below which an explosive gas atmosphere does not form, expressed as a percentage volume.

NOTE: This is also known as 'lower flammable limit' (LFL).

1.3.23 Machine mounted (detector)

A gas detector fitted to mobile and transportable mining machinery to provide continuous sensing coverage in the immediate vicinity of the machine.

NOTE: Machine mounted detectors are typically coupled to tripping devices to de-energize the machine in the presence of elevated levels of flammable gases.

1.3.24 Percentage volume (%v/v)

Percentage of the volume of a target gas to the volume of the gas mixture.

1.3.25 Poisons (of sensors)

Substances that lead to temporary or permanent loss of sensitivity of the sensors.

1.3.26 Portable—handheld (detector)

A gas detector designed to be carried from place to place by a person and able to measure gas concentrations while being carried.

NOTE: Portable detectors are most typically worn on the person, to measure gas concentrations in the immediate vicinity of the person.

1.3.27 Prescribed intervals

The minimum frequency of repetition for the particular activity.

1.3.27.1 *Each shift/before use*

Prescribed inspections/tests to be conducted immediately before the detector is taken from its designated holding area to be deployed in the field.

NOTE: This frequency of inspection and test is most applicable to portable and handheld detectors carried on the person. For gas chromatographs, 'before use' should be interpreted as prior to analysis of each set of bag samples.

1.3.27.2 *Daily*

Inspections/tests to be conducted daily.

1.3.27.3 *Weekly*

Inspections/tests to be conducted once in each calendar week.

1.3.27.4 *Monthly*

Inspections/tests to be conducted once in each calendar month.

1.3.27.5 *Six monthly*

Inspections/tests to be conducted every six months.

1.3.27.6 *On relocation*

Inspections/tests to be conducted after—

- (a) a fixed detector is redeployed having been repositioned or relocated and where electrical or signalling connections are re-made;
- (b) a machine mounted detector is redeployed having been repositioned or relocated and where electrical or signalling connections are re-made;
- (c) a transportable detector is redeployed after having been powered down and repowered; and
- (d) a sample line is redeployed having been repositioned or relocated.

NOTE: Re-testing of detectors after relocation is needed to prove that connections re-made to the detector are serviceable.

1.3.27.7 On return to service

On every occasion that a gas detector is re-installed after having been repaired, overhauled or otherwise been taken out of service and removed from its normal operating location, or where sensors or sensor heads are changed or replaced with the equipment in its normal operating location.

NOTE: The re-testing of detectors on return to service is needed to prove that any repairs, adjustment or connections made to the detector are serviceable.

1.3.28 Remote sensor

Sensor that is not integral with the main body of the detector.

1.3.29 Response time

The time interval (t_x) between a step increase in gas concentration at the sensor input and the detector reaching a stated fractional indication expressed as a percentage.

NOTE: The response time is typically expressed as t_{50} or t_{90} being the time required to reach 50% and 90% of the final indication respectively.

1.3.30 Sample line

A continuous tube or like conduit by which the gas being sampled is drawn from the point of sampling to the sensor element.

1.3.31 Sensing element or sensor element

That part of a sensor or gas detector that reacts in the presence of a target gas to produce a physical or chemical change that can be deterministically interpreted to yield a measured concentration and/or activate an alarm.

1.3.32 Sensor

An assembly containing a sensing element, sometimes together with signal conditioning, translation or buffering circuitry, that provides a signal to a logic solver to generate a measurement of concentration and/or alarm.

NOTE: The output of a sensor may be an analogue or digitized signal. It may use electrical, optical or other signalling media to communicate with the gas detector body.

1.3.33 Sensor head

A detachable or remote sub-assembly that contains a sensor.

NOTE: Sensor heads maybe field replaceable components that do not require disassembly of the gas detector to effect sensor replacement.

1.3.34 Span

That sub-range of the full operating range of the gas detector that includes at least the zero point and the uppermost alarm setpoint.

NOTE: The term 'span' is sometimes also used as a verb as in 'to span a gas detector'.

1.3.35 Span adjustment

Adjustment of a detector's sensitivity in accordance with the detector manufacturer's instruction to correct the detector's response to a span gas.

1.3.36 Span gas

A test gas that enables a gas detector to be exercised at a concentration exceeding the uppermost alarm setpoint of the gas detection system.

NOTES:

- 1 A test gas can be a certified gas mix, or a dilution of pure gases made using suitable mixing equipment.

- 2 It is recommended that the span gas concentration be at least 20% greater than the uppermost alarm setpoint of the gas detector to enable reasonable measurement accuracy to be obtained.
- 3 Where the gas detector is used (as part of a safety system) at concentrations above the uppermost alarm setpoint (for example at NERZ/ERZ boundaries), then the span gas concentration should be chosen to include the range above the uppermost alarm setpoint.
- 4 Figure C2 in Appendix C provides guidance on the relationship between span gas concentration and response time for a given alarm level.

1.3.37 Span test

Application of a span gas to the detector without adjustments to zero, sensitivity, or alarm level to verify the correct operation of the detector.

NOTE: The term 'span check' is sometimes used in place of 'span test'.

1.3.38 Toxic gas

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

NOTES:

- 1 For the purposes of this Standard, the word 'toxic' should be taken to include 'very toxic', 'toxic', 'harmful', 'corrosive', 'irritating', 'sensitizing', 'carcinogenic', 'mutagenic', 'teratogenic'.
- 2 'Toxic' gases also include asphyxiants.

1.3.39 Transportable (detector)

A gas detector 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.

1.3.40 Tube bundle system

A system in which a gas sample is conveyed from the point of sampling to a remote sensor element using forced reticulation through sample lines.

NOTES:

- 1 The tube bundle system includes any accessory fittings such as particle filters or water traps.
- 2 The associated sensor may be located underground or on the mine surface.

1.3.41 8-hour time weighted average (TWA)

The average gas concentration calculated over an eight-hour period.

NOTE: Time weighted averages are typically used where sustained exposure to low concentrations of toxic gases is considered hazardous, even though the instantaneous concentration is itself not considered hazardous.

1.3.42 Upper explosive limit (UEL)

Volume fraction of flammable gas or vapour in air above which an explosive gas atmosphere does not form, expressed as a percentage volume.

NOTE: This is also known as 'upper flammable limit' (UFL).

1.3.43 Zero adjustment

Adjustment of a detector's zero setpoint to correct the detector's response to clean air or zero gas, undertaken in accordance with the detector manufacturer's instruction.

1.3.44 Zero gas

A test gas specified by the equipment manufacturer for the purpose of calibration/adjustment of the detector's zero set point.

NOTE: In some instances clean air is used as a zero gas.

SECTION 2 GENERAL REQUIREMENTS

2.1 GENERAL

This Section describes the general requirements for inspection, maintenance and user servicing of gas detection and monitoring apparatus.

The inspection and maintenance requirements of gas detectors are determined by a number of factors, including the following:

- (a) Operating environment (vulnerability to damage, contamination, poisoning).
- (b) Operating modes (passive versus aspirated sensing, local versus remote sensing, local versus telemetric indication).
- (c) Criticality (in the context of safety systems).

2.2 ACCURACY REQUIREMENTS

The accuracy requirements of portable handheld, machine mounted, fixed and transportable gas detectors shall be in accordance with Appendix A.

The accuracy of tube bundle analysers shall be in accordance with the respective manufacturer's specifications.

2.3 REMOTE ALARMS AND TRIPPING FUNCTIONS

Where gas detectors are used to initiate alarms and/or tripping functions remote to the detector itself, a requirement to test alarms shall include verification of the actuation of the remote alarms and tripping functions.

NOTES:

- 1 While it is typically more convenient to reference only the local display on the gas detector when verifying operation, the telemetry link is an integral part of the safety system. The requirement to check remote alarms and tripping functions is to ensure that all associated telemetry and activation systems downstream of the detector are also functioning correctly.
- 2 Verification of the actuation of the remote alarms and tripping devices can utilize testing functionality built into the detector by the manufacturer for that purpose.

2.4 EQUIPMENT WITH MULTIPLE RANGE SETTINGS

Where gas detectors have multiple range settings, the periodic inspections and tests shall be carried for each range that is used in service.

2.5 RECORD KEEPING

Records of maintenance of gas detectors and associated apparatus shall be retained for at least the greater of—

- (a) one calendar month; or
- (b) four times the applicable test period.

NOTES:

- 1 For example, records of monthly tests are to be retained for at least four months after testing.
- 2 It is recommended practice to retain records of maintenance indefinitely while ever the item of equipment remains in service.

2.6 USER SERVICEABLE ITEMS

User servicing of gas detectors is limited to the following items, and only where explicit instruction is provided by the equipment manufacturer:

- (a) The adjustment of zero, span and calibration and other user configurable parameters.
- (b) The cleaning of filters and barriers.
- (c) The addition or replacement of sensors or sensor heads.

Any service work undertaken by the user shall—

- (i) be performed by an authorized person;
- (ii) be done in accordance with manufacturer's instructions;
- (iii) be restricted to components and parts provided by or approved by the equipment manufacturer; and
- (iv) not compromise the explosion-protection properties of the equipment.

NOTE: Depending on the technology deployed, the addition or replacement of sensors or sensor heads may invalidate the existing calibration certificate, and necessitate a new calibration to be performed. This should be confirmed with reference to the calibration certificate details.