

Australian/New Zealand Standard™

Electrical equipment for explosive gas atmospheres—Selection, installation and maintenance

Part 1: General requirements



AS/NZS 2381.1:2005

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Australian Gas Association
Australian Industry Group
Australian Liquefied Petroleum Gas Association
Australian Paint Manufacturers Federation
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Australian/New Zealand Standard™

Electrical equipment for explosive gas atmospheres—Selection, installation and maintenance

Part 1: General requirements

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-014, *Electrical Equipment in Hazardous Areas*, to supersede AS/NZS 2381.1:1999 and Amendment 1:2004.

This Standard incorporates Amendment No. 1 (September 2005), Amendment No. 2 (December 2006) and Amendment No. 3 (October 2007). 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.

The Joint Committee EL-014 has endorsed the adoption of the IEC 60079 Gases and vapours and IEC 61241 Dusts series of Standards as Joint Australian/New Zealand Standards. The different Zones are identified as Zone 0, 1, 2 for explosive gases atmospheres and Zones 20, 21, 22 for explosive dust atmospheres.

The significant changes in this edition are as follows:

- (a) The removal of all references to combustible dusts other than references in the Clauses 1.2 and 2.5 stating that the requirements for dusts are given in AS/NZS 61241.14.
- (b) Clauses 1.6, 2.4.6, 2.6, 3.8.4, 3.8.15.1.2, 3.11.2, 4.2, 4.3.1 and 5.10 were reworded.
- (c) Clauses 3.2.6 and 4.3.2 were added.
- (d) Appendices B and F were deleted.
- (e) Appendix G has changed title and content.
- (f) Appendix I has been added.

All permitted explosion-protection techniques for electrical equipment for Zones 0, 1 and 2 and the respective applicable Standards are summarized in Table 2.1.

This Standard necessarily deals with existing conditions, but it is not intended to discourage invention or to exclude materials, equipment and methods which may be developed in the future.

This revision which is to accommodate the introduction of AS/NZS 61241.14 for dusts, will have a relatively short currency, since it is planned to replace it with modified versions of IEC 60079-14 and IEC 60079-17 as AS/NZS 60079.14 and AS/NZS 60079.17, as part of a strategy for alignment with IEC Standards. Publication of AS/NZS 60079.14 and AS/NZS 60079.17, is expected for early 2007.

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.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

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FOREWORD

Many gases, vapours and mists that are generated, processed, handled and stored, are combustible. When ignited they can burn rapidly and with considerable explosive force if mixed with air in the appropriate proportions. It is often necessary to use electrical equipment in locations where such combustible materials are present, and suitable precautions must therefore be taken to ensure that all such equipment is adequately protected so as to reduce the likelihood of ignition of the external explosive atmosphere. In electrical equipment, potential ignition sources include electrical arcs and sparks, hot surfaces, and frictional sparks.

Areas where gases, vapours and mists occur in dangerous quantities are classified as hazardous.

Generally, electrical safety is ensured by the implementation of one of two considerations, i.e. that electrical equipment be located where reasonably practicable outside hazardous areas and that electrical equipment be designed, installed and maintained in accordance with measures recommended for the area in which the equipment is located.

Several techniques are available for the explosion-protection of electrical equipment in explosive gas hazardous areas. This Standard describes the safety features of these types of explosion-protection techniques and specifies the installation and maintenance procedures to be adopted. It is most important that the correct selection, installation and maintenance procedures be followed to ensure the safe use of electrical equipment in hazardous areas.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard**Electrical equipment for explosive gas atmospheres—Selection,
installation and maintenance****Part 1: General requirements**

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies general requirements, additional to those required for basic electrical safety, for the selection of electrical equipment and instruments, and associated equipment, and for the electrical equipment's installation and maintenance to ensure safe use in hazardous areas where flammable materials are generated, prepared, processed, handled, stored or otherwise used.

This Standard does not apply to those materials which are specifically manufactured as explosives, or to materials which are inherently explosive or pyrophoric. Explosive materials may require special considerations which are beyond the scope of this Standard.

The requirements of this Standard apply only to the use of electrical equipment under normal or near normal atmospheric conditions. For other conditions, additional precautions may be necessary. For example, most flammable materials and many materials which are normally regarded as non-flammable might burn vigorously under conditions of oxygen enrichment. Other precautions might also be necessary in the use of electrical equipment under conditions of extreme temperature and pressure. Such precautions are beyond the scope of this Standard.

Precautions which may be necessary against the effects of static electricity and against lightning are also outside the scope of this Standard, except for the general recommendations indicated in Clause 1.9.

1.2 APPLICATION

The requirements specified in this Standard are supplementary to and not alternative to any requirements given in AS/NZS 3000. Any alterations or modifications to AS/NZS 3000 in this document are specifically stated.

Installation of electrical equipment for explosive gas atmospheres shall comply with the requirements of this Standard and any additional requirements contained in other relevant parts of the AS 2381 series. Requirements for combustible dusts are given in the AS/NZS 61241 series and AS/NZS 60079 series. However, the requirements of this Standard may be varied by other relevant parts of the AS 2381 series for the types of protection concerned, in which case the requirements of other parts shall take precedence over this Standard.

Notwithstanding application of the installation requirements of this Standard to new installations, the requirements for inspection shall be applied to all electrical equipment and installations irrespective of age and date of installation.

1.3 REFERENCED DOCUMENTS

A list of documents referred to in this Standard is given in Appendix A.

1.4 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.4.1 Approved, approval

With the approval of, acceptable to, the authority having jurisdiction.

1.4.2 Area

A three-dimensional region or space.

1.4.3 Area, hazardous

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 electrical equipment.

1.4.4 Area, non-hazardous

Area in which an explosive atmosphere is not expected to be present in quantities such as to require special precautions for the construction, installation and use of electrical equipment.

1.4.5 Authority, authority having jurisdiction

The regulatory authority, having statutory (legal) control over the installation.

1.4.6 Cable trunking system

A system of trunking lengths and components, used for the accommodation and protection of cables.

1.4.7 Canned pump

A motor pump unit in which the integral pump chamber opens to the rotor of an induction motor, no shaft seals being provided.

1.4.8 Chemical compatibility

Suitability of materials used for the construction of the equipment and its installation, having regard to the solvent and corrosive agencies which may be present.

1.4.9 Competent person

A person who can demonstrate a combination of knowledge and skills to effectively, efficiently and safely carry out activities in hazardous areas, covered by this Standard.

Competency in some cases may be limited to one or more specific types of protection technique, e.g. Ex 'd', Ex 'i', etc and/or activity (e.g. design, selection, installation, maintenance, testing and inspection).

1.4.10 Degree of protection of enclosures

Measure applied to the enclosures of electrical equipment as defined in AS 60529 to provide for—

- (a) the protection of persons against contact with or approach to live parts and against contact with moving parts (other than smooth rotating shafts and the like) inside the enclosure and protection of the equipment against ingress of solid foreign bodies; and
- (b) the protection of the equipment inside the enclosure against harmful ingress of water.

1.4.11 Earth sheath return (ESR) system

A wiring system using the outer sheath of the cable as a combined neutral and earth return conductor.

1.4.12 Electrical apparatus

Items applied as a whole or in part for the utilization of electrical energy. These include, among others, items for the generation, transmission, distribution, storage, measurement, regulation, conversion and consumption of electrical energy and items for telecommunications.

NOTE: This definition is for alignment with the terminology contained in the IEC Standards being adopted by Australia/New Zealand.

1.4.13 Equipotential bonding

The electrical connection of exposed metal parts so that they are at substantially the same voltage under normal and fault conditions.

1.4.14 Ex component

A part of electrical apparatus for potentially explosive atmospheres, which is not intended to be used alone in such atmospheres and requires additional certification when incorporated into electrical apparatus or systems for use in potentially explosive atmospheres.

1.4.15 Explosive atmosphere

Mixture with air under atmospheric conditions, of flammable materials in the form of gas, vapour or mist in which, after ignition, combustion spreads throughout the unconsumed mixture.

1.4.16 Explosion-protection

Technique of protection which is applied to equipment or part of equipment to prevent the ignition of flammable vapours and gases in hazardous areas.

NOTE: Whereas formerly it was common for an individual item of equipment to be protected by one type of protection only, increasingly equipment may be protected by two or more types of protection. Thus, a rotating machine may incorporate a motor carcass in type of protection Ex 'd': Flameproof enclosure, and a terminal box in type of protection Ex 'e': Increased safety. Strictly it is now more satisfactory to refer to 'explosion-protected' equipment rather than to any one type.

1.4.17 Flammable gas or vapour

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

NOTE: This definition applies to all vapours of flammable liquids.

1.4.18 Flammable liquid

Any Class 3.1 or Class 3.2 liquid having a flashpoint of not more than 61°C.

1.4.19 Flammable material

Gas, vapour or liquid which can react continuously under appropriate concentration conditions with atmospheric oxygen and which may therefore sustain fire or explosion when such reaction is initiated by a suitable spark, flame or hot surface.

NOTE: Many liquids, though regarded as flammable, nevertheless do not normally burn. The application of heat to such materials serves to release vapour which may burn with atmospheric oxygen. The heat of the subsequent reaction serves to release further vapour for combustion.

1.4.20 Flashpoint

Lowest liquid temperature at which, under certain standardized conditions, a liquid gives off vapours in sufficient quantity such as to be capable of forming an ignitable vapour/air mixture.

NOTES:

- 1 Flashpoint data are normally associated with liquids, though they are also relevant to solids which sublime (refer to AS/NZS 60079.12 and AS/NZS 60079.20). Care must be taken in the use of flashpoint data in applications where the ignition source may itself raise the temperature of the combustible material.
- 2 The value for the flashpoint depends to some extent on the method of test. For the purposes of this Standard, flashpoint data are determined in accordance with AS 2106.

1.4.21 Hazard

Presence, or the risk of the presence, of an explosive mixture of a flammable material with air.

1.4.22 Heavy maintenance ('base maintenance')

Maintenance which generally consists of close and detailed checks to Standard JAR-145.

NOTE: JAR-145 is used internationally by the aircraft industry for the maintenance of aircraft.

1.4.23 Ignition source

Source of energy, which may comprise of naked flames, hot surfaces, exposed incandescent material, incendive sparks or hot particles, sufficient to ignite an explosive atmosphere.

1.4.24 Ignition temperature (of an explosive gas atmosphere)

Lowest temperature of a heated surface at which, under specified conditions in accordance with AS/NZS 60079.4, the ignition of a flammable material in the form of a gas or vapour in mixture with air, will occur.

1.4.25 Inherently explosive

Denotes explosives which require only a specific level of energy for ignition.

NOTE: An example of these materials is nitroglycerine.

1.4.26 Inspection

An action comprising careful scrutiny of an item carried out either without dismantling or with partial dismantling as required, supplemented by means such as measurement, in order to arrive at a reliable conclusion as to the condition of an item.

The different grades of inspection are as follows:

- (a) *Visual inspection*—an inspection which identifies, without the use of access equipment or tools, those defects, such as missing bolts, which will be apparent to the eye.
- (b) *Close inspection*—an inspection which encompasses those aspects covered by a visual inspection and, in addition, identifies those defects, such as loose bolts, which will be apparent only by the use of access equipment, such as steps (where necessary) and tools. Close inspections do not normally require the enclosure to be opened or the equipment to be de-energized.
- (c) *Detailed inspection*—an inspection which encompasses those aspects covered by a close inspection and, in addition, identifies those defects, such as loose terminations, which will only be apparent by opening the enclosure, and using (where necessary) tools and test equipment.

The different types of inspection are as follows:

- (i) *Initial inspection*—an inspection of all electrical equipment, systems and installations before they are brought into service.
- (ii) *Periodic inspection*—an inspection of all electrical equipment, systems and installations carried out on routine basis.
- (iii) *Sample inspection*—an inspection of a proportion of the electrical equipment, systems and installations.

1.4.27 Instrument

Electrical or light-emitting equipment for the measurement, control or computation of physical or chemical quantities.

1.4.28 Lower explosive limit (LEL)

Concentration of flammable gas, vapour or mist in air, below which an explosive gas atmosphere will not be formed.

1.4.29 Maintenance

A combination of any actions carried out to retain an item in, or restore it to, conditions in which it is able to meet the requirements of the relevant specification and perform its required functions.

1.4.30 Maximum surface temperature

Highest temperature attained in service under the most adverse conditions (but within the tolerances) by any part of the surface of electrical equipment which, if exceeded, would be able to produce an ignition of the surrounding atmosphere.

NOTES:

- 1 The most adverse conditions include recognized overloads and any fault conditions recognized in the specific Standard for the type of protection concerned.
- 2 For equipment with type of protection Ex 'd', the surface to be considered is the external surface. For equipment with other types of explosion-protection, internal surfaces are equally important if the explosive atmosphere has access thereto.

1.4.31 Non-incendive equipment

Equipment, other than an enclosed-break device, with contacts for making and breaking a potentially incendive circuit where either the contacts, the contacting mechanism, or the enclosure in which the contacts are housed are so constructed that the equipment prevents ignition of the prescribed flammable gas or vapour under specified operating conditions.

1.4.32 Pyrophoric

A substance that takes fire spontaneously on exposure to air (e.g. phosphorus) or water (e.g. potassium or sodium).

1.4.33 Overhaul

Action to restore to a fully serviceable condition equipment which has been in use or in storage for a period of time but is not faulty.

1.4.34 Repair

Action to restore faulty equipment to its fully serviceable condition, in compliance with the relevant Standard.

1.4.35 Source of release

Point or location from which a flammable material may be released into the atmosphere, so that an explosive atmosphere could be formed.

1.4.36 Temperature classification

System of classification by which electrical equipment is allocated one of six temperature classes according to its maximum surface temperature.

1.4.37 Unprotected surface

Surface to which an explosive atmosphere has access, and which is not explosion-protected other than by its own temperature limitation.

1.4.38 Upper explosive limit (UEL)

Concentration of flammable gas, vapour or mist in air, above which an explosive gas atmosphere will not be formed.

1.4.39 Verification dossier

A set of documents showing the compliance of electrical equipment and installations.

1.4.40 Wiring, open

System of wiring in which unsheathed cables are installed without further protection.

1.4.41 Zones, hazardous

The zones into which hazardous areas are classified based upon the frequency of the appearance and duration of an explosive atmosphere.

1.4.42 Zones in explosive gas atmospheres

See AS/NZS 60079.10 for the definitions of Zones 0, 1 and 2.

1.5 STATUTORY REGULATIONS

Equipment and installations where hazardous areas exist are required to comply with the applicable regulations of New Zealand or the applicable Australian State or Territory. It should be borne in mind that an installation can come under the jurisdiction of several authorities with different areas of responsibility, e.g. mining, electrical safety, handling and transport of flammable materials and occupational health and safety.

The installation and maintenance requirements contained in this Standard are supplementary and not alternative to any regulations which apply to installations in hazardous areas.

1.6 DOCUMENTATION

It is necessary to ensure that any installation complies with the appropriate certification documents as well as with this Standard and any other requirements specific to the plant on which the installation takes place.

To achieve this result, a verification dossier shall be prepared for every plant and shall be either kept on the premises or stored in another location in which case a document shall be left on the premises indicating who the owner or owners are and where that information is kept, so that when required, copies may be obtained. This dossier should contain the information detailed in the appropriate Parts of this series of Standards for the types of protection concerned.

Up-to-date information typically required is as follows:

- (a) Where applicable a statement of the identity of the person(s) having legal ownership of the installation or parts thereof and where the verification dossier is located.
- (b) The classification of hazardous areas and the Standards used for the classification.
- (c) Equipment group and temperature class.
- (d) Installation instructions.

- (e) Documentation/certification for electrical equipment, including those items with special conditions, for example, equipment with certificate numbers that have the suffix 'X'.
- (f) Descriptive system document for the intrinsically safe system.
- (g) Documentation relating to the suitability of the equipment for the area and environment to which it will be exposed, e.g. T rating, Ex rating, IP rating, corrosion resistance.
- (h) Documentation certifying that the equipment is rated for the voltages and frequency applied during normal operation.
- (i) Manufacturer's/qualified person's declaration, e.g. tradesperson's documentation and inspector's inspection reports.
- (j) Records sufficient to enable the explosion-protected equipment to be maintained in accordance with its type of protection (for example, list and location of equipment, spares, technical information).
- (k) Records covering any maintenance, overhaul and repair of the equipment.
- (l) Records of selection criteria for cable entry systems for compliance with the requirements for the particular explosion technique.
- (m) Drawings and schedules relating to circuit identification (see Clause 3.8.16).
- (n) In New Zealand, the Hazardous Area Statement of Periodic Verification on completion of a periodic inspection. (Refer to Appendix B).

Where alternative methods of equipment identification are used for inspection in accordance with Clause 4.3 then additional documentation to support the traceability of the equipment shall be provided.

It shall be the responsibility of the person(s) having legal ownership of the installation or parts thereof to ensure that the relevant information is produced but the preparation of the document may be delegated to expert bodies/organizations.

The dossier may be kept as hard copy or in electronic form.

1.7 QUALIFICATIONS OF PERSONNEL

The design, construction, maintenance, testing and inspection of installations covered by this Standard shall be carried out only by competent persons whose training has included instruction on the various types of protection and installation practices, relevant rules and regulations and on the general principles of area classification. The competency of the person shall be relevant to the type of work to be undertaken.

Appropriate continuing education or training should be undertaken by personnel on a regular basis.

Competency may be demonstrated in accordance with AS/NZS 4761, *Competencies for working with electrical equipment for hazardous areas (EEHA)*, or equivalent training and assessment framework.

1.8 CLASSIFICATION OF HAZARDOUS AREAS

This Standard is based on the concept, which is accepted internationally, of dealing with the risk of fire and explosion by area classification.

The classification of hazardous areas is dealt with within Zone 0, 1 and 2 areas by AS/NZS 60079.10 and the AS/NZS 2430.3 series.

It shall be the responsibility of the person(s) having legal ownership of the electrical installation, or parts thereof, to provide the information to the electrical tradespersons as to what is the zoning of the hazardous area.

1.9 OTHER CONSIDERATIONS

1.9.1 Protection from mechanical damage and environmental injury influences

All electrical equipment shall be designed, selected, installed and maintained to withstand damage which might reasonably be expected to result from mechanical damage and environmental influences likely to be encountered. Both the effect of the material causing the area to be classified as a hazardous area and the effect of the environment shall be taken into account.

1.9.2 Ambient temperature

Particular attention should be paid to the ambient temperature in which the equipment is designed to operate as most equipment is designed for an ambient temperature of -20°C to $+40^{\circ}\text{C}$. However, in some parts of Australia and New Zealand the ambient temperatures are outside this range. Therefore equipment may need to be selected, installed and maintained to take into account these higher or lower ambient temperatures.

1.9.3 Use of aluminium or light alloys

Particular consideration shall be given to the location of equipment which incorporates aluminium or light alloys in the construction of its enclosure. The propensity for such materials to give rise to sparking which is incendive under conditions of frictional contact has been well established. Suitable precautions shall therefore be taken to ensure that such frictional contact is avoided (see Appendix C).

1.9.4 Toxic risks

No account is taken in this Standard of the toxic risks which are associated with most flammable materials in concentrations which are usually very much less than the lower explosive limit.

In locations where personnel may be exposed to potentially toxic concentrations of flammable material, appropriate precautions, which are outside the scope of this Standard, should be taken.

NOTE: For further information, refer to the relevant departments/authorities in New Zealand or in each Australian State.

1.9.5 Non-electrical ignition sources

In any installation, irrespective of size, there may be numerous sources of ignition apart from those associated with electrical equipment. Adequate precautions should be taken in these circumstances to ensure safety. Such precautions are beyond the scope of this Standard.

1.9.6 Static electricity

Static electrical charges may accumulate to levels which could be incendive. Static charges may be caused by such mechanisms as friction, or movement of non-conducting materials (such as plastics or paper) or gases or liquids flowing through pipelines. Measures shall be taken to control static electricity and various approaches may be adopted according to the particular conditions under consideration. Detailed recommendations for the control of risks due to static electricity are given in AS/NZS 1020.

1.9.7 Lightning

In the design of electrical installations, steps shall be taken to reduce to a safe level the effects of lightning. Precautions to take against lightning are described in AS/NZS 1768.

1.9.8 Electromagnetic radiation

It may be necessary to take special precautions for installations in the vicinity of sources of electromagnetic radiation, such as high-frequency radio and radar transmitters in which case reference should be made to BS 6656 and BS 6657.

1.9.9 Radiation from optical equipment

It may be necessary to take special precautions for optical equipment in the form of lamps, lasers, LEDs, optical fibres, etc. which is used for lighting, surveying, communications, sensing and measurement. This optical equipment may be used in or near to explosive gas atmospheres, and in this case radiation from this equipment can pass through these atmospheres. The radiation can be absorbed by surfaces or particles, causing them to heat up, and in certain circumstances this allows them to attain a temperature that will ignite a surrounding gas atmosphere.

NOTE: Appendix D contains a report on a research project into the safe operation of optical instruments using intense light sources. The conclusions give recommendations for certain limiting values of power and flux.

1.9.10 Cathodic protection

Cathodically protected metallic parts located in hazardous areas are live extraneous conductive parts which shall be considered potentially dangerous (especially if equipped with an impressed current system) despite their low negative potential.

No cathodic protection shall be provided for metallic parts in Zone 0 and Zone 20 unless it is specially designed for this application.

NOTE: Detailed guidelines for the cathodic protection of metals are described in the various parts of AS 2832 and in BS 7361. BS 7361 should be used when reinspecting cathodic protection systems.

1.9.11 Personal equipment

Items of personal equipment which are battery-operated (e.g. hearing aids, miniature transistor radios, key-ring torches, calculators, watches, pagers, cellular phones, and remote control car keys) are sometimes carried by personnel and might be taken, inadvertently, into a hazardous area. These items can constitute a potential source of ignition and should not be taken into a hazardous area unless—

- (a) they are verified as complying with Clause 2.6; or
- (b) the risk has been assessed by a competent person as being acceptable; or
- (c) a permit guaranteeing the absence of an explosive atmosphere has been issued.
- (d) they can be considered as simple apparatus as defined in AS/NZS 60079.11.

1.10 PREVENTION OF EXPLOSION

1.10.1 General

Preventive measures aimed at the elimination of the risk of a simultaneous occurrence of a source of ignition and an explosive atmosphere in the area under consideration may be used.

The problem may be approached in any one of the following ways, each of which has its own appropriate field of application:

- (a) Suppression or avoidance of the hazardous condition.
- (b) The use of explosion-protected electrical equipment.
- (c) Conditions of control applied to procedural, automatic or manual means by which the simultaneous occurrence of an explosive atmosphere together with a source of ignition is prevented.

Although each method of prevention can be a complete solution to a particular problem in itself, it is permissible and sometimes advantageous to use a combination of techniques to obtain the required degree of safety.

1.10.2 Suppression or avoidance

1.10.2.1 Segregation

The ultimate level of complete safety can only be assured when the hazardous materials are segregated. Where practicable, electrical equipment generally, switchgear and controlgear particularly, should be installed in a non-hazardous area.

The equipment may be installed in a non-hazardous area in the open air, segregated in a room or compartment which is non-hazardous or, in some instances, behind an impervious barrier which separates the equipment from the hazardous area.

1.10.2.2 Total enclosure of flammable material

It is sometimes possible to reduce the hazard by containing the flammable material in totally enclosed vessels and piping systems.

1.10.3 Explosion-protected electrical equipment

Various techniques of explosion-protection may be applied to equipment or parts of equipment to provide an assurance of safety. The types of protection considered in this Standard are detailed in Clause 2.4.

Where more than one explosion-protection technique is used, each relevant part of the equipment or system shall maintain the properties of that particular technique.

1.10.4 Conditions of control

In certain cases it is only by the addition of methods or conditions of control that the required degree of safety can be obtained. Such methods may include the use of procedures and/or the use of monitoring devices, such as gas detectors, or pressure, temperature or flow devices. Depending on the degree and type of hazard involved, the associated conditions of control initiated by the monitoring device may include one of the following:

- (a) Automatic disconnection of the power supply.
- (b) Automatic initiation of an alarm followed by an associated manual procedure to restore the integrity of the system.
- (c) A manual procedure, whereby one or other of the parameters necessary for an explosive condition is retained under continuous control.

1.11 PRECAUTIONS

1.11.1 General

For equipment protected by other than intrinsic safety protection (see AS 2381.7), the precautions set out in Clauses 1.11.2 or 1.11.3, as applicable, shall be taken when carrying out installation, maintenance and inspection work in a hazardous area.

1.11.2 Equipment rendered 'not alive'

Equipment rendered 'not alive' may be opened in hazardous areas. For equipment to be rendered 'not alive' the following conditions shall be met:

- (a) The equipment has been disconnected from its source of supply.
- (b) Effective measures, such as the locking of the isolating switch in the open position, have been taken to prevent equipment being enlivened before reassembly.

NOTES:

- 1 Particular attention should be paid to equipment that may be live even after it has been disconnected from a source of supply. For heavy rotating machinery, the back e.m.f. of such plant should be considered and precautions will usually need to be taken to ensure that the equipment, or any associated equipment, is not opened until the rotating plant is stationary.
- 2 Most power capacitors are fitted with discharge resistors and these take a finite time to bring the terminal voltage to a harmless value.
- 3 Emergency lighting fittings, or other equipment using batteries, can be rendered 'not alive' providing the battery is fitted with a means of isolation and has no live exposed parts, or can be fully discharged before opening. Additional action may be also required to ensure that all sources of mains supply are isolated, as many emergency lighting fittings are wired with active, neutral, unswitched active, and possibly unswitched neutral.

1.11.3 Equipment not rendered 'not alive'

In circumstances where work on live conductors is unavoidable, it shall be ensured that adequate precautions are taken both initially and periodically to verify that the presence of flammable gas, vapour or combustible dust, if any, does not constitute an explosive atmosphere.

Such precautions may include the use of a suitable monitoring device.

An audit trail shall be kept to verify that adequate precautions have been taken.

NOTE: It is typical practice to have safe working limits for flammable gas or vapour concentration of 0% LEL for HOT WORK. The place of measurement should be judiciously chosen to determine the highest concentration of gas in the area.

WARNING: MOST FLAMMABLE MATERIALS ARE TOXIC IN CONCENTRATIONS WHICH ARE USUALLY VERY MUCH LESS THAN THE LOWER EXPLOSIVE LIMIT (LEL).

1.11.4 Igniting agencies

No operation involving the use of an open flame or other source of ignition shall be attempted in a hazardous area until the conditions have been made safe by the control of the flammable material which may give rise to the risk. Such operations shall only be undertaken on written authority confirming that adequate control measures have been taken and that tests have been made and are repeated at sufficiently frequent intervals to ensure that safe conditions are maintained.

NOTE: See Note to Clause 1.11.3.

SECTION 2 SELECTION OF ELECTRICAL EQUIPMENT

2.1 SCOPE OF SECTION

This Section details the general factors to be considered in the selection of electrical equipment for hazardous areas. The selection procedures which apply to particular types of protection are described in the appropriate Parts of this series of Standards.

2.2 SPECIFIC EQUIPMENT NOT PERMITTED IN HAZARDOUS AREAS

The following electrical equipment shall not be installed in hazardous areas:

- (a) Battery chargers with their control equipment and batteries being charged, unless such equipment is suitable for the hazardous area.
- (b) Low pressure sodium vapour discharge lamps.

2.3 PERMITTED EQUIPMENT

Except where otherwise specified, electrical equipment selected for use in a hazardous area shall be protected by one or a combination of the explosion-protection techniques set out in Clause 2.4 for equipment in Zones 0, 1 and 2.

2.4 ZONE 0, 1 AND 2 HAZARDOUS AREAS

2.4.1 Required information

Generally in order to select appropriate electrical equipment for use in a Zone 0, 1 and 2 area, the following required information shall be considered:

- (a) The classification of the area, i.e. the zone.
- (b) The temperature class or ignition temperature of the gas or vapour involved, or the lowest value of ignition temperature if more than one flammable material could be present. This will permit determination of the temperature classification required for the equipment, or the upper limiting temperature for any unprotected surface.
- (c) Where applicable, the group or the characteristics of the gas or vapour involved in relation to—
 - (i) igniting current or minimum ignition energy for installations of intrinsically safe equipment; or
 - (ii) safe gap data in the case of installations for flameproof enclosures.
- (d) Other considerations in accordance with Clause 1.9.

NOTES:

- 1 Generally for equipment with types of protection 'p', 'e', 'n' and, where applicable, 's', only the area classification and ignition temperature are required. However, where equipment is protected by Ex 'i' (intrinsic safety) or Ex 'd' (flameproof enclosure) in addition to one of these types of protection, it is necessary to determine the appropriate equipment grouping (see Clause 2.4.4).
- 2 Where there is a combination of combustible dust and flammable gas or vapour, explosion-protection alone may not be sufficient. Until specific guidance is available, expert advice should be sought.

2.4.2 Selection with respect to area classification

The type of explosion-protection technique for electrical equipment shall be selected according to the area classification.

Electrical equipment in Zone 0, 1 and 2 areas shall be protected by one or a combination of explosion-protection techniques specified in Table 2.1 for the appropriate zonal area.

2.4.3 Selection with respect to temperature classification

2.4.3.1 *Reference ambient temperature*

Electrical equipment for hazardous areas is normally designed for use in an ambient temperature range between -20°C and $+40^{\circ}\text{C}$, unless otherwise marked.

2.4.3.2 *Maximum surface temperature (temperature class)*

A hot surface can cause an ignition, therefore it is necessary to ensure that the surface temperature of equipment introduced into a hazardous area does not exceed the ignition temperature of the gas or vapour.

The permitted maximum surface temperatures are classified as follows:

- (a) For Group I electrical equipment:
 - (i) Where coal dust can form a layer 150°C .
 - (ii) For internal surfaces, where the above risk is avoided, e.g. by sealing against the ingress of dust . . . 450°C .
- (b) For Group II electrical equipment those values in Table 2.2 which correspond to the temperature class of equipment, having regard to the maximum ambient temperature for which the equipment is designed.

In decisions concerning the maximum surface temperature for equipment or the suitability of available equipment which is to operate in an area endangered by a particular material, the maximum surface temperature of the equipment should not exceed the ignition temperature of the gas or vapour. For example, naphtha has an ignition temperature of 290°C and the appropriate temperature classification for equipment would therefore be T3, implying a maximum surface temperature of 200°C . Equipment in the T2 category would not be suitable as this would imply surface temperatures of up to 300°C . However, special equipment limited specifically to a temperature below 290°C (e.g. 280°C) would be acceptable, and should be marked accordingly (see AS 2380.1 and AS/NZS 60079.0 for marking details).

For components having a total surface area of not more than 10 cm^2 , e.g. integrated circuits, transistors or resistors used in intrinsically safe electrical circuits, their surface temperature may exceed that for the temperature class marked on the electrical equipment if it can be demonstrated that there is no risk of ignition from these components (see AS 2380.1 and AS/NZS 60079.0).

Equipment designed for use in a maximum ambient temperature of 40°C may be used in higher temperatures provided that—

- (a) the equipment is assigned a higher temperature classification;
- (b) the temperature rise of the equipment (related to 40°C) plus the higher ambient temperature is less than the ignition temperature of the flammable material; or
- (c) the maximum temperature of the particular temperature class plus the higher ambient temperature is less than the ignition temperature of the flammable material.

TABLE 2.1
EXPLOSION-PROTECTION TECHNIQUES FOR
ELECTRICAL EQUIPMENT IN ZONE 0, 1 AND 2 HAZARDOUS AREAS

Description of explosion protection technique	Applicable Standards and designated symbol	Remarks
ZONE 0¹⁾		
Intrinsically safe	AS 2380.7 AS/NZS 60079.11 Ex 'ia'	
Encapsulated	AS/NZS 60079.18 Ex 'ma'	
Special protection	AS 1826 Ex 's'	In accordance with the requirements for Zone 0
ZONE 1²⁾		
Intrinsically safe	AS 2380.7 AS/NZS 60079.11 Ex 'ib'	
Special protection	AS 1826 Ex 's'	In accordance with the requirements for Zone 1
Flameproof enclosure	AS 2380.2 AS/NZS 60079.1 Ex 'd'	
Encapsulated	AS 2431 Ex 'm' AS/NZS 60079.18 Ex 'mb'	
Pressurized rooms or pressurized enclosures	AS 2380.4 AS/NZS 60079.2 Ex 'p'	In accordance with the requirements for Zone 1
Increased safety	AS 2380.6 AS/NZS 60079.7 Ex 'e'	
Ventilation	AS 1482 Ex 'v'	In accordance with the requirements for Zone 1
Powder filling	AS/NZS 60079.5 Ex 'q'	
Oil immersion	AS/NZS 60079.6 Ex 'o'	
ZONE 2³⁾		
Special protection	AS 1826 Ex 's'	In accordance with the requirements for Zone 2
Non-sparking	AS 2380.9 IEC 60079-15 AS/NZS 60079.15 Ex 'n'	2nd Edition (2001) of IEC 60079-15 is not acceptable
Ventilation	AS 1482 Ex 'v'	In accordance with the requirements for Zone 2
Pressurized rooms or pressurized enclosures	AS 2380.4 AS/NZS 60079.2 Ex 'p'	In accordance with the requirements for Zone 2

¹⁾ Equipment suitable for Zone 1 or 2 that has an interface for Zone 0 should comply with AS/NZS 60079.26 (Int.). (Note: Due to the recent publication of IEC 60079-26 compliance is not yet mandatory)

²⁾ Equipment suitable for use in Zone 0 can also be used in Zone 1 and Zone 2.

³⁾ Equipment suitable for use in Zone 0 or Zone 1 can be also used in Zone 2.

NOTES:

¹ All the Joint Standards (AS/NZS) shown in this Table are identical to the respective adopted IEC Standards.

² AS 2380.2/6/7 were withdrawn on 28 February 2005.

³ Publication of AS/NZS 60079.18 and AS/NZS 60079.26 (Int.) is expected for mid 2005.

⁴ Publication of AS/NZS 60079.15 is expected for late 2005.

TABLE 2.2
CLASSIFICATION OF MAXIMUM SURFACE
TEMPERATURES FOR GROUP II
ELECTRICAL EQUIPMENT

Temperature class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

NOTES:

- 1 A reference ambient temperature of 40°C is normally assumed when equipment is designed to operate within one of the temperature classes indicated in the Table. Where the reference temperature is outside the range of -20° to +40°C, the value is required to be marked on the equipment (see AS 2380.1 and AS/NZS 60079.0).
- 2 Ignition temperatures of flammable liquids, gases and volatile solids are given in AS/NZS 60079.20.

2.4.4 Selection with respect to equipment grouping

2.4.4.1 Group designation

Electrical equipment for hazardous gas areas is grouped as follows:

- (a) Group I—electrical equipment for mines susceptible to methane.
- (b) Group II—electrical equipment for all places with an explosive gas atmosphere, other than mines susceptible to methane.

2.4.4.2 Group II subdivisions

For certain types of protection, such as flameproof (Ex 'd') and intrinsic safety (Ex 'i'), Group II is further subdivided into subgroups IIA, IIB or IIC and shall be selected in accordance with Table 2.3. (See Appendix E and AS/NZS 60079.20.)

Where equipment is marked indicating it has been tested with a single gas or vapour, it shall only be permitted where other gases or vapours are present, when the equipment is verified as suitable.

TABLE 2.3
RELATIONSHIP BETWEEN GAS/VAPOUR SUBDIVISIONS
AND SUITABLE EQUIPMENT SUBGROUPS

Gas/vapour subdivision	Suitable equipment subgroups
IIA	IIA, IIB, or IIC
IIB	IIB or IIC
IIC	IIC

2.4.5 Enclosures with internal sources of release

When an enclosure contains an internal source of release of potentially explosive gas, vapour or mist, the type of explosion-protection required is dependent upon the area classification surrounding the enclosure and the type and extent of release of flammable substance within the enclosure.

NOTE: For further information refer to Appendix F.

2.4.6 Motors supplied at varying frequency and voltages

Ex 'd' and Ex 'p' motors supplied at varying frequency and voltages are required to meet the requirements of either Item (a) or Item (b), Ex 'e' motors are required to comply with Item (b), and Ex 'n' motors are required to comply with Item (b) or (c), as follows:

- (a) There shall be means (or equipment) for direct temperature control by embedded temperature sensors specified in the motor manufacturer's documentation or other effective measures for limiting the surface temperature of the motor housing. The action of the protective device shall be to cause the motor to be disconnected. The motor and convertor combined need not be tested together.
- (b) The motor shall be type-tested for this duty as a unit in association with the convertor specified in the descriptive documents and with the protective device provided.
- (c) The motor temperature rise shall be assessed by calculation in accordance with the requirements of AS 2380.9, for the duty required/specified.

All motors shall have filters or other means to reduce the effects of circulating currents and damage to bearings.

NOTES:

- 1 In some cases, the highest surface temperature occurs on the motor shaft.
- 2 For motors with protection type 'e' terminal boxes, and when using convertors with high-frequency pulses in the output, care should be taken to ensure that any overvoltage spikes and higher temperatures that may be produced in the terminal box are taken into consideration.

2.4.7 Trace heating

Electrical resistance trace heating equipment should comply with AS/NZS 62086.1.

2.5 ZONES 20, 21 AND 22 HAZARDOUS AREAS

Installations in combustible dust areas, Zones 20, 21 and 22 shall comply with AS/NZS 61241.14.

2.6 ASSURANCE OF CONFORMITY OF APPARATUS

2.6.1 Use of certified apparatus

Certified apparatus shall be used as it provides the necessary assurance that apparatus meets the requirements of the appropriate Standard.

Acceptable certification of apparatus shall be covered by a Certificate of Conformity which—

- (a) is issued in accordance with a Type 5 Scheme complying with ISO/IEC Guide 67; and
- (b) is issued by a body operating within the IECEx Scheme or by a certification body with accreditation by JAS-ANZ or an organization that has a Mutual Recognition Agreement (MRA) with JAS-ANZ covering Product Certification of Explosion Protected Equipment; and
- (c) meets the requirements of Appendix G.

A1,
A2
and
A3

Equipment certified under the IECEx Scheme and registered on the IECEx database (www.iecex.com) or the ANZEx Scheme registered on the Administering Body database (www.anzex.com.au) meets these criteria. Equipment certified under the AUSEx Scheme is acceptable.

NOTES:

- 1 Appendix I provides further information about the AUSEx, ANZEx and IECEx schemes.
- 2 For Ex 'v' installations and where Ex 'p' is applied to buildings and the like which are assembled and/or installed on site, certification may not be appropriate. In such installations a statement of assessment by a competent person may be accepted.

2.6.2 Other acceptable certification

Apart from simple apparatus used within an intrinsically safe circuit, the use of apparatus, not meeting the criteria of Clause 2.6.1, should be restricted to exceptional circumstances, e.g. research, development, pilot plant and other new project work where apparatus carrying other certification is available or is more appropriate.

2.6.2.1 For Australia

In Australia, electrical apparatus certified to an alternative Standard to those referenced in Clause 2.4 may be used. In such cases the apparatus and its installation shall provide an equivalent level of safety and users shall obtain a Conformity Assessment document. Where apparatus to alternate Standards are accepted by the legal owners of the installation then any selection, installation, inspection, maintenance, overhaul or repair associated with those alternate Standards shall be nominated and followed. It shall be the responsibility of the legal owners of the installation to ensure that the justification for use is documented and placed in the verification dossier. Such justification shall be carried out by a competent person. The legal owners shall also document acceptance of the apparatus.

NOTES:

- 1 For Group I installations such apparatus requires approval of the regulatory authority.
- 2 Regulatory authorities may specify additional requirements for acceptance of apparatus certified to alternative Standards, e.g. Notification, application for a 'Letter of No Objection', review by nominated parties. In such cases these requirements shall be followed.
- 3 A conformity assessment document is to provide evidence that a certificate to an alternative Standard can be demonstrated to provide an equivalent level of safety to AS/NZS or IEC Standards. This would normally involve a comparison of the relevant Standards and verification that testing has been conducted by a third party.

2.6.2.2 For New Zealand

Proof of compliance can be demonstrated with one of the following regimes of compliance (including any marking requirements):

- (a) European Council Directive 94/9/EC (ATEX) on Hazardous Area Equipment.
- (b) For battery powered equipment without integrated chargers—
 - (i) approvals issued by FM Approvals of the United States of America; or
 - (ii) certified by Underwriters Laboratories Inc (UL) of the United States of America to ANSI/UL 60079 series of Standards.

All the requirements applying to the supplier/sponsor/manufacture under these regimes or systems, shall be met by a person or organization located in New Zealand who is responsible for the supply of product in New Zealand. The person or organization in New Zealand may at times be a company importing the product directly for their own use.

Where the products are made to Standards that do not have equivalent selection, installation, maintenance and inspection requirements then those Standards will have to be obtained and followed.

NOTE: For ATEX this will include the person or organization located in New Zealand supplying product into New Zealand holding copies of the certificates and supporting documentation, as the European Manufacturer is required to under ATEX, in New Zealand.

2.7 SELECTION OF REPAIRED OR EXISTING EQUIPMENT

When it is intended that existing equipment, or repaired equipment, is to be installed in a hazardous area that is deemed to be a new installation, the requirements of Clauses 2.2 to 2.6 apply, as appropriate. In addition, the procedure set out in Figure 2.1 shall be followed.

NOTE: The act of introducing other than like for like apparatus (i.e. identical characteristics and protection technique) in an existing installation may cause that installation to be deemed 'new'.



Full document details: AS NZS 2381.1-2005 (2007)

SECTION 3 INSTALLATION

3.1 SCOPE OF SECTION

This Section sets out general requirements for installations in hazardous areas.

The installation procedures which apply to particular types of explosion-protection are described in the appropriate Parts of this series of Standards.

3.2 GENERAL INSTALLATION REQUIREMENTS

3.2.1 General

The installation of equipment shall be carried out in a manner that does not reduce the type of explosion-protection afforded by the equipment design.

3.2.2 Access

Installations generally shall be designed and the equipment and materials installed with a view to ensuring ease of access for inspection and maintenance.

3.2.3 Electrical rating

Electrical equipment and materials shall be installed, used and maintained for use only within their electrical ratings. These ratings include power, voltage, current, frequency, duty and temperature.

3.2.4 Associated equipment located in non-hazardous areas

Consideration shall be given to equipment associated with hazardous area equipment but which is located in non-hazardous area e.g. protection devices, variable speed controllers and the like.

3.2.5 Intrinsically safe installations

Intrinsically safe installations shall comply with the requirements of Section 3 where applicable, except for Clauses 3.3, 3.4, 3.5, 3.6, 3.7, 3.8.8, 3.8.15.1, 3.8.15.2, 3.8.15.3, 3.10, 3.11 and 3.12.

3.2.6 Equipment identification

Where alternative means for equipment identification is applied in accordance with Clause 4.3 then an alternative identification tag shall be attached to the equipment. Alternative tags shall be fixed in a manner that does not reduce the integrity of the equipment and is in compliance with the equipment certification.

3.3 EARTHING*

3.3.1 General

The metal parts of electrical equipment installed in hazardous areas, shall be earthed as required by AS/NZS 3000, plus any additional requirements specified in this Standard.

In New Zealand, care should be taken to ensure that the safety hazardous area is not compromised by an earth potential rise created by a neutral current flowing in an earth conductor, as a result of links in switchboards between neutral and earth conductors in installations constructed prior to 1993.

* This Clause does not apply to intrinsically safe installations.