Engineering

Technical Standard

TS 0376 - Classification and Design for Electrical Equipment in Hazardous Areas

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Application and Interpretation of this Document

It is the responsibility of the users of this Standard to ensure that the application of information is appropriate and that any designs based on this Standard are fit for SA Water's purposes and comply with all relevant Australian Standards, Acts and regulations.

Users of this Standard accept sole responsibility for interpretation and use of the information contained in this Standard. Users should independently verify the accuracy, fitness for purpose and application of information contained in this Standard.

Only the current revision of this Standard should be used which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

Nil – This is the first revision of this Technical Standard.

Document Controls

Revision History

Revision	Date	Author	Comments
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1 Introduction

SA Water owns and operates sites which contain hazardous areas and associated certified hazardous area electrical assets. This Technical Standard has been developed to provide a framework and standardise design, supply, installation and maintenance techniques for electrical hazardous area equipment and installation at SA Water sites.

This technical standard shall be read in conjunction with the associated project specification, drawings and any documents annexed to the project specification. The provisions of this technical standard shall apply unless they are specifically deleted or amended in the project specification or drawings which shall then take precedence, however, any requirement that does not comply with this technical standard shall be required to be approved by the SA Water Principal Electrical Engineer.

The currency of these Standards should be checked prior to use.

1.1 Purpose

The purpose of this Technical Standard is to provide minimum standards and practices for the classification of hazardous areas and the design, construction, operation and maintenance of SA Water's electrical assets located in hazardous areas. In setting these minimum standards, SA Water seeks to maintain the consistency and quality of their hazardous area electrical assets as well as compliance to state legislation.

1.2 Acronyms, Abbreviations and Definitions

The following acronyms, abbreviations and definitions are used in this document:

Table 1 - Table of Acronyms, Abbreviations and Definitions Used in this Technical Standard

Term	Description
EEHA	Electrical Equipment in Hazardous Areas
ELV	Extra Low Voltage
HA	Hazardous Area(s)
IP	Ingress Protection
IS	Intrinsically Safe
LEL	Lower Explosive Limit
LV	Low Voltage
MDP	Maximum Dissipated Power
NH	Non Hazardous
OCU	Odour Control Unit
SA Water	South Australian Water Corporation
SPS	Sewer Pump Station
SWA	Steel Wire Armoured
TS	SA Water Technical Standard
UEL	Upper Explosive Limit
WWTP	Waste Water Treatment Plant

1.3 Standards and Codes

The regulatory framework covering electrical equipment installed within hazardous areas falls under the general requirements for electrical safety which are detailed via legislation in the form of:

- South Australian Work Health and Safety Act 2012
- South Australian Work Health and Safety Regulations 2012
- South Australia, Electricity Act 1996
- South Australia, Electricity (General) Regulations 2012

The above legislation mandates adherence to AS/NZS 3000 "The Wiring Rules". AS/NZS 3000 requires that the classification of hazardous areas complies with AS/NZS 60079.10 and electrical equipment installed within hazardous areas complies with AS/NZS 60079.14 and AS/NZS 60079.17.

Any standard referred to in this specification shall be of the latest edition (including amendments) of that standard at the date of calling of tenders.

The following standards and codes are referred to in this specification, either directly or indirectly implied.

1.3.1 Australia Standards

The following table identifies the standards, documents and/or articles that are referenced in this document:

Table 2 - Australian Standards used in this Document

Number	Title
AS/NZS 3000	Wiring Rules
AS/NZS 3008.1.1	Electrical installations—Selection of cables—Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions
AS/NZS 3800	Electrical equipment for explosive atmospheres – Repair and Overhaul
AS/NZS 4761.1	Competencies for working with electrical equipment for hazardous areas (EEHA)—Competency Standards
AS/NZS 60079.10.1	Classification of areas—Explosive gas atmospheres
AS/NZS 60079.10.2	Classification of areas—Combustible dust atmospheres
AS/NZS 60079.13	Equipment protection by pressurized room 'p' and artificially ventilated room 'v'
AS/NZS 60079.14	Design selection, erection and initial inspection
AS/NZS 60079.17	Electrical installations inspection and maintenance
AS/NZS 60079.20.1	Material characteristics for gas and vapour classification—Test methods and data

1.3.2 International Standards

Table 3 - International Standards used in this Document

Number	Title

1.3.3 Guidelines

NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities

1.3.4 SA Water Technical Standards

The following table identifies the SA Water Technical Standards, documents and/or articles that are referenced in this document:

Table 4 – SA Water Standards used in this Document

Number	Title
TS 0100	Requirements for Technical Drawings
TS 0120	Electronic Security Installation Standards
TS 0133	Requirements for Asset Labelling
TS 0300	Supply and Installation of Low Voltage Electrical Equipment
TS 0307	Fire Detection and Emergency Evacuation Systems

Drawings and documentation shall comply with SA Water Standard TS 0100.

2 Scope

This Technical Standard covers the general requirements for the following sub-sections as they relate to hazardous areas:

- Classification
- Design
- Equipment Selection
- Installation
- Inspection and Testing
- Maintenance
- Verification Dossier

It is important that the above activities are carried out in such a way as to ensure the integrity of the hazardous area installation. Undertaking these activities in accordance with the Australian standards and this document will preserve the explosion protection characteristics of installed apparatus and minimise the risk of explosion with protected equipment as a source of ignition.

This Technical Standard applies to all SA Water sites, assets on SA Water premises, projects, investigations and engineering design modifications. The document shall be read in conjunction with associated project specifications, drawings and any documents annexed to the project specification. The provisions of this Technical Standard shall apply unless they are specifically deleted or amended in the project specification or drawings which shall then take precedence.

This document is not intended to replace Australian Standards, but it is intended to clarify areas of standards that are open to interpretation, or where good industry practice should be applied.

Important preamble:

When plant or facilities are designed, it is imperative that sound engineering practices are followed to minimise risk, such that the frequency and size of potentially explosive atmospheres is as low as is reasonably practicable, to ensure that the resultant hazardous areas are minimised in severity, quantity and size.

2.1 Approval to Deviate from This Standard

Approval may ultimately be granted by the SA Water Principal Electrical Engineer, to deviate from the requirements as stipulated in this Standard, if the functional requirements (e.g. asset life, ease of use, maintainability, etc.) for the asset differs from those stated in the Standard, but is assessed as still being acceptable. Any approval to deviate from the stated requirements of this Standard shall not be seen as creating a precedent for future like projects. Any request to deviate from this Standard must be carried out on a project by project basis, where each alternative proposal will be individually assessed on its own merit. No action should be taken until a written reply to such a request has been received.

SA Water encourages and welcomes suggestions as to the improvement of this standard for future releases. These suggestions should be passed through to the SA Water Principal Electrical Engineer.

2.2 Design Criteria

The design criteria must be ascertained and agreed with SA Water or its representative during all stages of investigation, concept design and detailed design in order to achieve a value-for-money installation that is fit for purpose and with minimum or negligible risks to SA Water. The design criteria should consider the following aspects:

1. Safety Considerations

   The installations are to be designed with the safety and welfare of construction, operation and maintenance personnel and the general public in mind, complying with statutory regulations. Wherever possible, electrical equipment and wiring should not be located in areas classified as hazardous.

2. Environmental Considerations

   The installations are to be designed and suitable equipment selected to avoid or minimize unacceptable impact on the environment as far as possible.

3. Life Cycle Costs

   Designs should be innovative and incorporate the appropriate techniques and technology, in conjunction with the selection of appropriate equipment, to minimize the life cycle costs, while satisfying operation and maintenance requirements. Energy consumption must be given particular attention in this respect.

4. Security of Operation

   Designs should take into account the failure of a single item of equipment or a fault in a particular area of an installation is confined to the associated part of the installation and does not affect the continuous operation of the remaining parts of the installation, where possible.

5. Reliability

   The installations are to be designed to minimize the likelihood of a failure, taking into consideration the electricity supply characteristics, ambient conditions, load characteristics and operation and maintenance requirements.

6. Upgradability

   The installations are to be designed to facilitate future upgrades where applicable.

7. Interchangeability

   The installations are to be designed to maximize the interchangeability of components and assemblies as far as practical to improve flexibility and reduce the spare parts inventory.

8. Operation, Maintenance and Fault-Finding Facilities

   The installations are to be provided with suitable and adequate facilities to allow ease of operation, maintenance and fault finding.

3 Hazardous Area Process

Generally, a Hazardous Area classification is carried out in three main parts:

1. Define the type of hazard
   a. Is the hazard a gas, vapour or dust, or a combination of two?
   b. Is there more than one material present?
   c. Consider the properties of the hazardous material present, such as vapour density.
2. Assess the probability of an explosive atmosphere occurring
   a. Identify the sources and grades of release (during normal or maintenance operations);
   b. Determine the frequency of release;
   c. Determine the quantity/duration of material likely to be released;
   d. Define ventilation; and
   e. Define Hazardous Area zones.
3. Produce the relevant documentation
   a. Hazardous Area classification drawings;
   b. Hazardous Area classification report; and
   c. Production of a, or addition to, the Hazardous Area Dossier for the site.

Area classification and review should only be carried out by competent persons who have a knowledge and understanding of the process and equipment. This would imply that a team of personnel may be required to provide expertise or requirements in relation to the hazardous area.

The following shows the steps required when working with hazardous areas, as well as references to associated sections within this document, and subsequent documentation requirements:

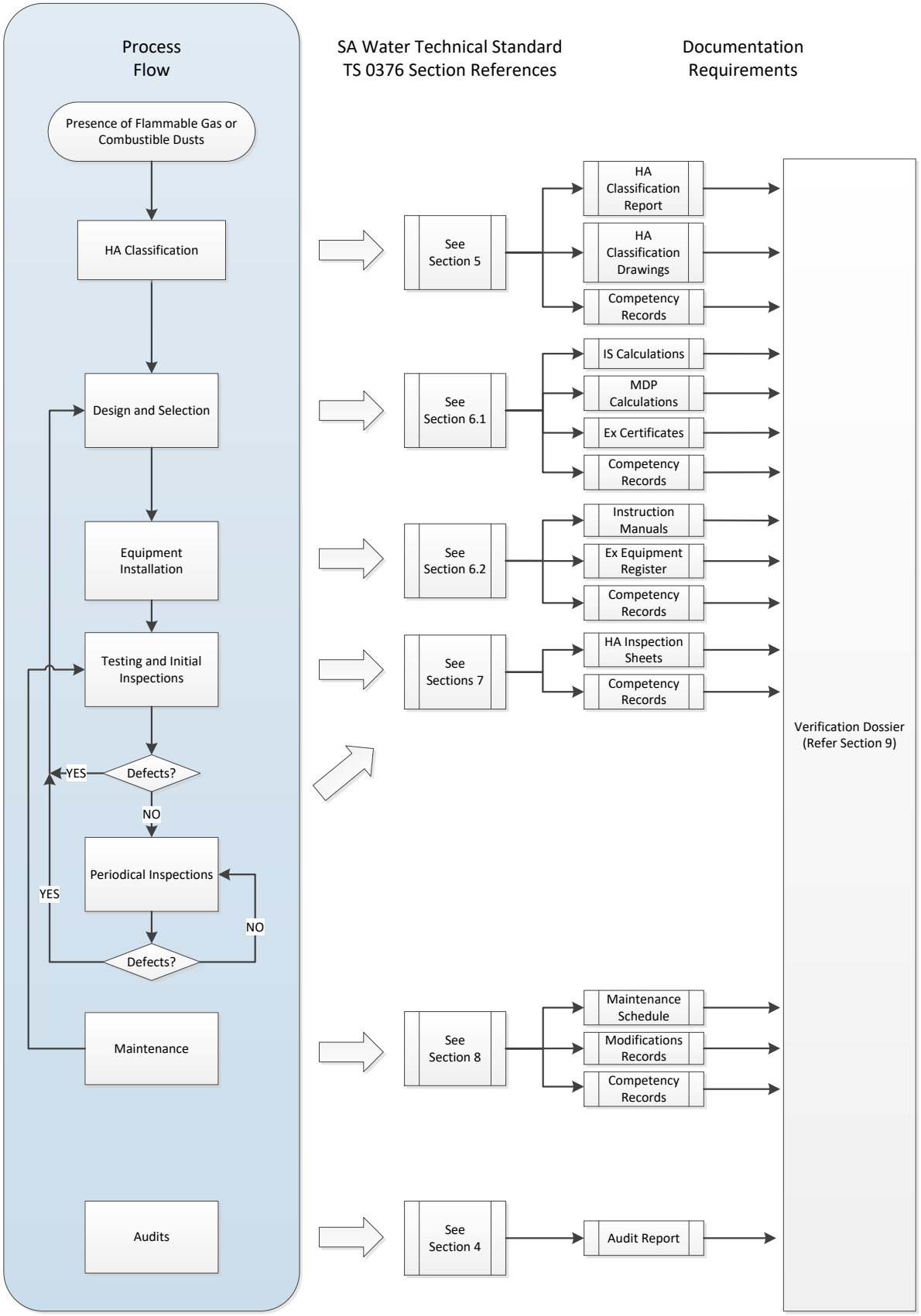


Figure 1 - Hazardous Area Process Flow Chart

4 Audits

To ensure that this Technical Standard is being applied consistently throughout all SA Water sites, an audit against this Technical Standard shall be required for any substantially sized or high-risk Hazardous Area installation project. The criteria to determine the applicability of this clause shall rest with the Designer and should prompted through the Safety in Design process at the concept phase of a project.

Where an audit report is required, it shall be undertaken by a suitably qualified third party not directly involved with the hazardous area project. An audit report shall be prepared and all stages of the Hazardous Area Process Flowchart (refer section 3 of this standard) shall be reviewed against the relevant Australian Standards.

The auditor shall be engaged sufficiently early during any project such that they can provide feedback at each stage of the project lifecycle, including, but not limited to:

1. Hazardous area classification;
2. Design;
3. Selection;
4. Installation;
5. Inspection and testing; and
6. Hazardous Area Dossier compilation.

Any non-conformances identified during the audit shall be recorded within the Audit Report in the form of a punch-list. The punch-list shall contain a column for the description of non-conformance rectification actions, a column for non-conformance sign-off by the designers or constructors, and also a column for sign off by SA Water (or a nominated representative).

A copy of the complete Audit Report shall be included in the final dossier, including evidence of the non-conformances that have been rectified and closed out.

5 Hazardous Area Classification

5.1 General

The objective of a hazardous area classification is to identify where in a plant there is a high probability that flammable gas, vapour or explosive dust might be seen in levels where an explosion may arise. This will then allow asset owners, operational and design personnel to implement appropriate control measures for equipment and activities within the relevant areas, based on the classified zones and their extent. These measures include the proper selection and installation of equipment for use in such hazardous areas.

Hazardous Area Classification shall be undertaken during early stages of the detailed design phase in order to permit correct mechanical and electrical design. A Hazardous Area Classification Report shall be prepared at this stage of the project to document the classification, assumptions, calculations and design requirements for civil, mechanical and electrical installations. On completion of the installation, an updated Hazardous Area Classification Report shall be prepared and included in the site Hazardous Area Verification Dossier to verify assumptions used in the early classification, and to reflect the final design and classification. Where a modification occurs in a hazardous area, the existing Hazardous Area Classification Report and drawings shall be updated to reflect these changes.

Classifications should be completed in accordance with AS/NZS 60079.10 .1 for gas classifications (and 10.2 for any dust classifications). In complying with this standard, the general classification methodologies should be applied, and documentation requirements and recommendations followed. This includes compilation of a report, materials properties and release schedules, and hazardous area drawings.

5.2 Properties of Flammable and Combustible Materials

5.2.1 General

Powered activated carbon used in the water treatment process is considered as combustible dust and flammable biogas may also be generated in wastewater assets. Flammable gas mixtures should be defined by an analysed composition, and gas properties measured or calculated based on the composition.

5.2.2 Combustible Dusts

The flammability of dusts should be determined by literature review or by laboratory testing, noting that flammability is often a function of particle size, as well as concentration and the material properties.

5.2.3 Biogas

Where an analysed biogas composition is not available, the following may be used:

Table 5 - Biogas Typical Gas Composition

Component	Concentration (mol %)
Methane	65
Carbon dioxide	34
Trace gases, including hydrogen sulphide	1

Because hydrogen sulphide is of a low concentration in the above composition and therefore will not significantly contribute in determining the mixture properties, the composition above may be classified as gas group IIA and temperature class T3.

5.2.4 Hydrogen Sulphide

Typically, hydrogen sulphide (H_2S) is generated in raw sewage under anaerobic conditions. H_2S is heavier than air and will tend to settle and accumulate in any troughs, depressions or areas of poor ventilation. Evolution of this flammable gas is likely to occur in sewer networks, WWTP inlet works, primary treatment and primary sludge treatment processes; however, the concentrations seen in these processes are unlikely to form explosive atmospheres. The explosive limit of H_2S is 4-44%, whereas concentrations seen in wastewater infrastructure are generally below 1000ppm, equivalent to 0.1% (volumetric concentration) or 2.5% of LEL for H_2S.

H_2S concentration in gases generated in Anaerobic Digesters and subsequent processes, such as Gas Separation Plants, can be as high as 3000ppm. Although H_2S alone at this concentration is still not flammable, high concentrations of methane are often generated and co-exists in the gas mixture generated in these processes and render the gas mixture flammable.

H_2S has a distinct odour that is noticeable at concentrations of low ppb range. Its toxicity limit ranges from the WHS prolonged exposure limit of 10ppm, acute toxicity at 100 to 500ppm, to the probability of instant death at 1000ppm. Confined space entry procedures apply to infrastructure that contains H_2S concentrations greater than 5ppm.

The gas is classed as an apparatus sub-group IIB fluid with temperature class of T3, due to its autoignition temperature of 260°C.

5.2.5 Workshop Fluids

Workshop fluids should be documented with gas groups and temperature classes identified. Hazardous area classifications shall be made according to the 'worst case' scenarios identified for each storage location.

5.3 Classification Methodology

5.3.1 Source of Release Method

The source of release method is the most commonly used method of classification when release sources can be identified, and impact can be reasonably assessed based on evidence of release data or industry experience. The method is summarised in Figure C.2 of AS/NZS 60079.10.1 and should be the default method of classification for SA Water facilities, where possible.

This method identifies individual sources of release, assesses release grade, and classifies the zone type based on ventilation impact, i.e. adequacy of natural ventilation or degree and availability of artificial ventilation. Zone extent for this classification method can be determined based on industry experience, calculations or computational modelling.

Dust classifications should be classified using a similar approach, with reference to AS/NZS 60079.10.2

5.3.1.1 Release Rate Calculations

Hydrogen sulphide generation rate for sewage:

In sewer systems with long hydraulic retention times, sewage can become septic and sulphate is converted into reduced sulphide compounds under anaerobic conditions as a result of biological reactions. This process is slow, and generally in a domestic sewer system, liquid phase sulphide is likely to be below 3mg/L. Higher sulphide levels are possible for high salinity

catchments or catchments with significant trade waste discharge. Under certain pH conditions, a proportion of sulphide can liberate as H_2S into the gas phase. This process is affected by temperature, turbulence, gas pressure and level of ventilation available.

H_2S generation in a sewer environment can be predicted using various mathematical models. For hazardous area classification purposes, the level of H_2S generation from raw sewage is so low in a domestic sewerage system that it is unlikely to become a source of release that will form an explosive environment, unless gas accumulates in dead zones where ventilation is not available. Up to 1000ppm has been measured in some sewers representing high H_2S generation potential, under limited ventilation. This is equivalent to 0.1% in volumetric concentration, noting that the LEL for H_2S is 4%.

Onerous H_2S generation, ventilation and dispersion modelling is not necessary for the classification of infrastructure that transport, contain or treat raw sewage. A generalised method shall be used to classify wastewater infrastructure associated with H_2S generation. More guidance on the classification of sewerage assets associated with H_2S generation is provided in Section 5.6 of this document.

Biogas generation rate for anaerobic digestion systems:

Anaerobic digestion is most commonly used for wastewater sludge treatment, generating biogas as a by-product that may form an explosive environment. The treatment process relies on a variety of bacteria thriving at an optimal temperature of around 35-38˚C with complete mixing. It also requires adequate reactive substrate being available, measured by its Chemical Oxygen Demand (COD) or Volatile Solids (VS) concentrations to sustain a biogas production rate of 0.85-1.2 Nm^3/kg VS destructed. Greater than 50% of biogas is seen to be generated within two hours of substrate being added to an active anaerobic digester. An anaerobic digestion system typically employs a sludge retention time of 15-20 days, therefore biogas generation potential is considerably reduced in sludge discharged from an effective anaerobic digestion process.

Biogas release shall be monitored to derive a suitable release rate, i.e. maximum rate of release at source $(dG/dt)_{max}$ in kg/s, for classification using the source of release method.

In the absence of site-specific values, the following value representing a typical design may be adopted as a conservative approach for biogas generation rate of fresh sludge from an active anaerobic digester. Note that the actual value may vary among sites depending on the design, operation and performance of anaerobic digesters.

$$G = 0.01 Nm^3/s \text{ per ML sludge}$$

When digested sludge leaves digesters, it cools down during transportation to the downstream processes. The sludge biogas generation rate then decreases considerably, resulting in significantly reduced biogas available for release. Hence, an availability factor should apply to the calculation of biogas release in downstream processes.

A factor of 0.2 to 0.5 should apply to downstream processes up to the gas separation facility. In a gas separation facility, biogas entrapped in sludge is released effectively and a factor of 0.02-0.05 should apply for sludge in the downstream processes, post a gas separation facility.

Furthermore, depending on the hydraulic condition, i.e. level of mixing available, or other conditions such as gas/liquid interface, temperature and vapour pressure, biogas release rate also varies in the downstream processes. For example, for a sludge holding tank with mixing equipment, biogas release is higher than a stagnant tank of similar size and dimension. Biogas release rate is higher in a tank with higher D/H ratio compared to a tall and narrow tank of the same volume.

Methane generation rate in wastewater processes upstream of anaerobic digestion:

Prior to the anaerobic digestion process, raw primary sludge, if held for extended periods, may generate gas mixtures similar to biogas composition, but this process occurs at a much slower

rate. Depending on the age of the sludge, a methane generation rate of 1% of digester sludge, i.e. $6x10^{-5}$ Nm^3/s per ML raw primary sludge, may be used for the purpose of source of release calculations in hazardous area classification.

Similarly, a methane generation rate of 0.1% of that for primary sludge, i.e. $6x10^{-8}$ Nm^3/s per ML raw sewage, may be used for the purpose of source of release calculations in hazardous area classifications for raw sewage processes. This considers a substrate concentration factor as well as impact from moisture content of primary sludge.

5.3.1.2 Acceptable Modelling Software

Plume dispersion modelling for outdoor gas releases should be performed using DNVGL PHAST or, if this is not available or not suitable, using some other equivalent software. The software should be commercially available and have appropriate validation documentation available to attest to the suitability and accuracy of the software outputs.

If it is determined that indoor gas releases are required to be modelled, computational fluid dynamics (CFD) software should be used. Similarly, validation documentation should be available to confirm that the software is appropriate for its intended purpose.

5.3.1.3 Assumptions and Basis for Input Parameters

Model configuration parameters used as input to dispersion modelling software should be based on the specific site conditions and will typically be as follows:

Table 6 – Dispersion Modelling Input Parameters

Weather Description							
Conditions		Very Stable	Stable	Neutral	Moderately unstable	Unstable	Very Unstable
Time		Night	Night	Day	Day	Day	Day
Wind		Low	Moderate	High	High	Light	Light
Solar (Day) / Cloud (Night)		Low	Moderate	Moderate	High	Moderate	High
Weather Parameters (i)							
Wind speed	m/s	0.1(ii)	1.5	5	5	1.5	1.0
Pasquill Stability	-	G	F	D	C	A/B	A
Surface Roughness Length	mm	[default]	[default]	[default]	[default]	[default]	[default]
Atmospheric Temperature	°C	10	10	30	35	30	35
Substrate Temperature	°C	10	10	30	50	30	50
Relative Humidity	%	70	70	70	50	70	50
Solar Radiation	kW/m^2	0	0	0.8	1.0	0.8	1.0

Notes:

(i) The weather parameters align with the descriptive definitions in Phast; see Figure 2.

(ii) PHAST modelling software is less reliable at modelling plume dispersions at low wind velocities, i.e., less than 1 m/s. For this reason, results from modelling performed at wind speeds of less than 1 m/s should be treated with caution. If typical wind speeds in the local area are rarely this low, this condition should not be included.

The input parameters in the above table are assigned a unique Pasquill Stability factor based on the combination of atmospheric conditions. Pasquill Stability describes the amount of turbulence in the atmosphere and is represented as a letter from A (very unstable) to G (very stable). The stability depends on the wind speed, time of day and other conditions as shown in Figure 2.

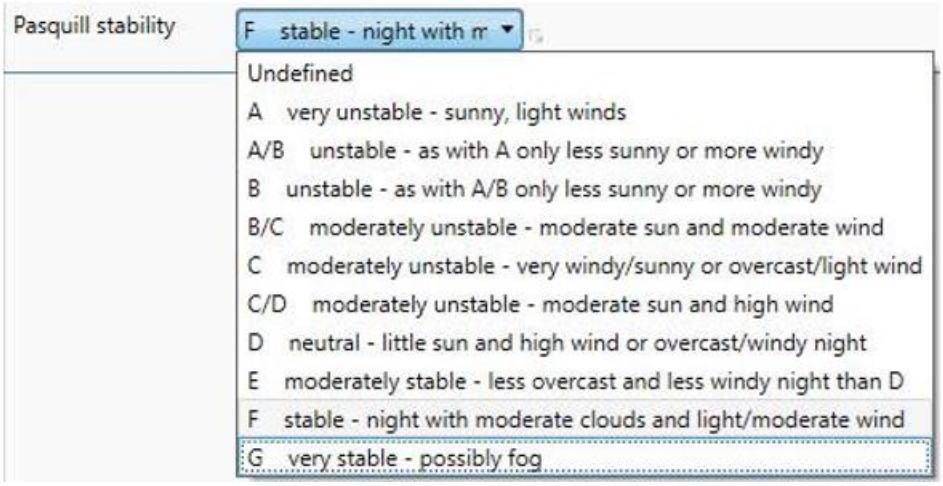


Figure 2 - Pasquill Stability Descriptions (extract from Phast v8.1 user manual)

Following from the modelling, the resulting hazardous area should be defined as a cylinder with the largest radius and largest height of all-weather scenarios modelled. This approach may be applied directly to vertical releases.

Additional consideration shall be given to the following:

a. Horizontal and angled releases: the model should consider the direction of release and the effect of the wind strength and direction.

b. Height of the release: though it is acknowledged that lighter than air gases, commonly found in SA Water facilities, will have less prominent ground effects, as opposed to heavier than air gases.

To account for uncertainties in the input data and calculation accuracy, a safety factor k is often applied. The safety factor represents the hypothetical volume at which the boundary concentration of the flammable gas or vapour cloud typically reduces to 0.25 or 0.5 times the LEL, depending on the value of a safety factor, k.

i.e. $k \times LEL_m$ where LEL_m is the lower explosive limit (mass per volume kg/m^3)

k would typically be 0.25 (for continuous and primary grades of release) or 0.5 (for secondary grades of release). A less onerous safety factor may be applied to the values obtained, by verified experience, or available manufacturers' data for the specific device, or to reasonable calculations based on reliable input data. Application of safety factors should ensure that the results obtained err on the side of safety.

5.3.2 Generalised Method

Where it is not practical to apply the source of release method for classifications due to release sources being located too closely together or where there is lack of detailed data or operating experience to identify and assess individual sources of release in a plant, a generalised method may be used. This method of classification may identify source of release, but in other cases release source may not be identified. This method does not generally calculate release rate or quantify dispersion characteristics of the flammable gas or vapour. Instead, a blanket type approach is applied to a large area or plant, and possibly to a group of gas and vapour mixers, to generalise the possibility of an explosive atmosphere being formed under certain operational scenarios and/or ventilation conditions.

Classification utilising the generalised method is characterised by larger zone areas and may result in more costly plant due to the over-conservativeness employed in such classifications. However, for areas where there is no source release data available and the hazardous area classification has little influence on plant design and equipment selection, the generalised method may be appropriate.

The example described in Annex ZB of AS/NZS 60079.10.1 using generalised method for areas associated with the production, processing, handling and storage of flammable liquids and gases in refineries and major processing plants shall not be used for SA Water's water and wastewater treatment facilities. SA Water's installations manage water, wastewater and sludge which is not flammable, but these processes may produce gases that may form hazardous atmospheres, and as such, the resulting classification may look different to that outlined in Annex ZB of AS/NZS 60079.10.1.

Where there is a large number of release sources within a small enclosed region, this method may be considered, though its use should be justified, and there should be no significant additional cost to the project brought about by unnecessary installation of hazardous area certified equipment and subsequent requirements.

5.3.3 Combination of Source of Release and Generalised Method

In practice, a combination of source of release and generalised method is commonly used in various stages of design. During an early concept design stage, the generalised method may be an appropriate and cost-effective approach to determine equipment separations, plant layout and boundaries without an onerous classification being conducted. Classification employing mainly source of release method is typically undertaken at the start of the detailed design phase to set out mechanical and ventilation requirements necessary to proceed through detailed design. Generalised method for some plants or parts of a plant, may be used when source of release method is not practical due to a high number of sources located closely together or due to lack of source data or operational experience.

Most cases in the classification examples of Annex ZA in AS/NZS 60079.10.1 utilise the source of release method with a few exceptions, where the generalised method is used. These examples represent common practice for specific industries and shall be referenced, where applicable, for the classification and design of similar processes. Particular note is made of clause ZA.8: Landfill gas, sewage treatment and sewage pumping plants, which may be applicable to SA Water assets. Further classification examples for SA Water specific applications are available in Section 5.6 of this document.

5.4 Ventilation Guidance

According to AS/NZS 60079.10.1, ventilation is described as being either natural or artificial.

Natural ventilation is associated with the 'classification by example' method in Annex ZA, and is described in section ZA.3. It uses the concept of adequate versus inadequate ventilation, which have different conditions for equipment, depending on whether located outside, or in sheltered structures. For open areas, natural ventilation is typically defined as adequate if air velocities are rarely below the minimum threshold of 0.5 m/s. For equipment in sheltered structures, adequate ventilation is determined by assessing, for example, the number of openings to the structure that are available for natural ventilation. Criteria to be used to assess the adequacy of natural ventilation for the purpose of hazardous area classification are listed in Table ZA.1, AS/NZS 60079.10.1.

Artificial ventilation may be either general or local and is not defined as adequate or inadequate the same way natural ventilation is. Artificial (mechanical) ventilation is associated with the 'generic source of release' classification method and defined in Annex B. This method defines the quality of the artificial ventilation with respect to two variables: by degree (low, medium or high) and availability (good, fair or poor). This method uses calculation to determine the degree of ventilation, and the resultant ventilation assessment is associated with a calculated zone size to determine the hazardous area classification. The calculation may

have to be repeated if there is a considerable long-term change in process conditions as well as significant changes in material composition.

During design and construction of a new facility, artificial ventilation is commonly used to protect equipment, reduce the classification or size of zoned areas.

AS/NZS 60079.13 gives requirements for the design, construction, assessment, verification and marking of rooms used to protect internal equipment by artificial ventilation when located:

- in a hazardous area with or without an internal source of a flammable gas or vapour; or
- in a non-hazardous area that has an internal source of release of a flammable gas or vapour.

In order to determine safety control requirements for artificially ventilated rooms, AS/NZS 60079.13 stipulates that the "*hazardous area shall first be classified without any ventilation*", before the required artificial ventilation minimum flow rate and arrangement may be determined. The minimum flow rate shall be defined according to AS/NZS60079.10.1 using dispersion modelling for classifications using the source of release method, so that it is sufficient to reduce the concentration of the gas or vapour to less than 25% of the lower flammable limit.

Where specific source of release and dispersion calculations cannot be undertaken as a reasonable approach due to lack of release source data, in order to specify minimum air flow requirements for adequate ventilation, international standards such as NFPA 820 may be used, where appropriate, using the generalised classification method. NFPA 820 is specifically written for wastewater treatment and collection facilities. In this standard, ventilation is defined by the number of air changes per hour for specific areas and applications in the facility.

5.5 Zone Extent Minimisation Techniques

Where possible, hazardous area sizes shall be reduced by implementing vapour barriers such as eliminating flanges and adding door seals to prevent migration of flammable gases into areas that are otherwise non-hazardous.

Mechanical ventilation may be used to great effect in reducing hazardous area zone sizes. However, the reliability of the ventilation and the response of the plant to ventilation failure must be taken into consideration in plant design, as well as during commissioning and testing of the facility, to ensure adequate ventilation is achieved for the purpose of hazardous area classification.

Where hazardous areas cannot be reduced or eliminated, design shall attempt to relocate equipment outside the hazardous area so far as is reasonably practical.

All considerations around zone extent minimisation shall be documented in the hazardous area report.

5.6 Classification Guidance – Common Applications

Specific guidance is given below for equipment commonly found at wastewater treatment facilities.

5.6.1 General

Classifications should be made preferentially using Australian Standards, specifically referring to AS/NZS 60079.10.1 and 60079.10.2.

Where specific guidance is not available in the Australian Standards, international standards such as EI-15 (Energy Institute, UK) and NFPA 820 (National Fire Protection Association, USA) may be referred to.

5.6.2 Combustible Dusts

Hazardous areas for combustible dusts should be determined in accordance with AS/NZS AS/NZS 60079.10.2.

The zone extents for combustible dusts should be determined by calculation, or by operating observation in the subject- or similar plant areas. It is acknowledged that calculation is unlikely to be accurate and it is recommended that a significant safety factor be applied to the calculation results.

5.6.3 Wastewater Network

Flammable gases, such as methane and hydrogen sulphide, are generated in the wastewater network due to long hydraulic retention times and as a result of biological growth on internal pipe walls under anaerobic conditions. Explosive atmospheres may exist in the network where ventilation is limited, and accumulation of flammable gases may occur. There have been rare occasions where methane levels have been recorded approaching the Lower Explosion Limit (LEL) within SA Water's major gravity network. Classification of all gravity trunk mains are considered overly conservative, and extensive monitoring of the entire network to understand the likelihood of Methane levels greater than 20% of LEL and classification at each location is unrealistic.

SA Water does not normally classify wastewater networks, however, where there is potential of an explosive atmosphere being present in a section of the network, a risk assessment shall be performed. Appropriate control measures should be implemented to minimise the risks identified in this risk assessment.

For locations where there is a history of high percentage of Methane (>20% of LEL) monitored, Hazardous Area classification is required, following the principles below:

- Zone 1 or 2 classification, depending on the level of ventilation available inside the infrastructure, for sewers (greater than 300mm diameter) and attachments, with no extension to outside infrastructure, such as vents or manholes.

5.6.4 Wastewater Pump Stations

In reference to AS/NZS 60079.10.1: 2009 Classification of areas – Explosive gas atmospheres, ZA.8.4 Sewage pumping plants:

"Generally, Sewage pumping plants are non-hazardous (NH). However, where the pumping station has a record of flammable liquids passed through it, areas where concentration of flammable vapour is likely to exceed the LEL should be classified in accordance with the relevant clauses of this Standard."

5.6.4.1 Wet Wells

Wet wells of wastewater pump stations that comply with SA Water standard SPS design are generally non-hazardous (NH). However, high concentrations of flammable gas have been detected in some SA Water sites, particularly where there is trade waste discharge or in high salinity catchments.

The following classification shall be applied to major wastewater pump stations that would be prone to, or have a history of gas accumulating in wet wells and overflow structures:

- Zone 0 classification, with no zone extension outside of the structure

Monitoring will be required to justify a lower classification. Conditional Zone 0 classification may apply when the condition for periodical occurrence can be defined and demonstrated based on monitoring results.

5.6.4.2 Dry Wells

Dry wells of wastewater pump stations that comply with the SA Water standard SPS dry well design requirement for ventilation are generally non-hazardous (NH), unless prone to, or have a history of flammable liquids passing through them.

Where there is a risk of gas levels being high, the preference is to improve ventilation in design to achieve a NH classification.

5.6.5 Treatment Facility Inlet Works

Wastewater treatment plant inlet works, including inflow channels, screens, grit removal tanks, pre-aeration channels, overflow channels/chambers, may contain flammable gases that could gather and concentrate in areas that have low air movement.

For ventilated inlet works infrastructure, explosive atmospheres may only be formed in dead zones, whereas most of the covered areas within the air flow path would have adequate ventilation to negate the need to be classified as a Hazardous Area. Ventilation and CFD modelling shall be required in order to determine the extent of explosive atmospheres, which could be tedious and impractical. In the absence of such modelling, a Zone 1 or 2 classification shall be given to enclosed areas, depending on the availability and effectiveness of foul air extraction systems.

A Zone 1 classification shall be given to covered inlet works without mechanical ventilation, i.e. an enclosed system with little air exchange from the outside environment.

The following classification principles apply to covered inlet works with foul air extraction systems:

- Zone 1 classification for enclosed areas where effectiveness of foul air extraction systems are compromised due to inadequate capacity.
- Zone 1 classification for systems with inadequate controls and interlocks that might cause plant to shut down or be turned off without the knowledge of operators.
- NH classification for enclosed areas with adequate ventilation systems equipped with duty/standby extraction fan and alarms and interlocks to ensure continuous operation of the foul air extraction system.

Given that the release rate of flammable gas for unpressurised systems such as this is extremely low, the no zoned area can be extended to the outside of a structure that is naturally well ventilated.

In addition, it should be flagged and made obvious on HAC drawings that the extent of zoned area is conditional, which shall prompt a review on HA classification if electrical instruments are to be installed within the area in the future.

The above principles also apply to other areas of a treatment facility where flammable gas entrapment may occur.

5.6.6 Foul Air Extraction and Odour Control Units (OCUs)

This clause applies to foul air extraction and OCUs within WWTP or OCU extracting foul air from a classified area.

In reference to AS/NZS 60079.10.1: 2009 Classification of areas – Explosive gas atmospheres, ZA.8.3.2.3 Inadequately ventilated locations, (d) (i) and Figure AZ.52:

"The interior of both inlet and exhaust ducts is assigned the same zonal classification as the enclosed structure being served."

However, given the conditions and reasoning behind classification for covered inlet works, as described in section 0, it is expected that:

- When an OCU is offline for a short period of time (days), it is unlikely for flammable gas to accumulate and fill the entire covered area and migrate into the OCU system on start-up.
- When an OCU is offline for an extended period (weeks to months), it is possible that an explosive environment may be formed, resulting in flashes upon OCU start-up.
- When an OCU is in operation, the foul air extracted would be from the air flow path of a covered area that is well ventilated, hence exhibiting a non-explosive atmosphere.

Therefore, the following classifications shall apply to OCUs (standard design) that extract foul air from covered inlet works:

- NH classification for systems with adequate redundancy and alarms and interlocks that will ensure continuous operation. (This precludes systems that might remain offline for extended periods.)
- Zone 2 classification otherwise.

For a NH classification, the HAC report and drawings shall clearly state the need for an OCU to be operated continuously with shutdown periods no longer than 3 days before normal start-up of the plant. Otherwise, an abnormal operating procedure (including monitoring of source atmosphere) shall be implemented to ensure the OCU is not extracting an explosive gas composition on plant start-up. A WWTP O&M manual shall be updated to reflect these procedures as part of the Hazardous Area Classification scope.

The following OCUs shall be classified differently, based on flammable gas emission rates:

- An OCU extracting foul air from systems with a history of extremely high methane contents; or
- An OCU extracting foul air from sources other than inlet works, with high concentrations of flammable gases.

5.6.7 Primary Sedimentation Tanks

Primary sedimentation tanks in WWTPs shall be classified based on the following principles:

- Zone 1 classification for covered and unventilated tanks, i.e. enclosed area.
- Zone 2 classification for covered tanks with mechanical ventilation.
- NH classification for uncovered tanks.

NH may apply for covered tanks if adequate ventilation is demonstrated through individual assessment.

5.6.8 Primary Sludge Holding Tanks

Primary Sludge Holding Tanks are designed to temporarily store primary sludge for short periods of time, normally 1-3 days before being transported off site or being treated by downstream sludge stabilisation processes. Primary sludge is rich in organic compounds and may generate flammable gases under anaerobic conditions during storage; however, the gas generation rate is much slower compared to a fully engineered Anaerobic Digester and is not classified as such. Guidance on typical methane generation rates for primary sludge processes is provided in Section 5.3.1.1.

For enclosed Primary Sludge Holding Tanks, without mechanical ventilation, the following principles apply:

- Zone 1 classification for ullage.
- Zone 2 classification for interior of vent ducts, and 0.5m laterally and vertically above manholes.
- Zone 2 classification for 0.5m radius around venting duct outlets.

5.6.9 Primary Gravity Thickeners

Primary Gravity Thickeners contain primary sludge under anaerobic conditions. Flammable gases may evolve, although at a much slower release rate compared to an engineered anaerobic digester.

For enclosed Primary Gravity Thickeners, without mechanical ventilation, the following classification principles apply:

- Zone 1 classification for ullage.
- Zone 1 classification for interior of vent ducts, and 0.5m laterally and vertically above manholes.
- Zone 2 classification for 0.5m radius around venting duct outlets.

Reference shall be made to Section 5.6.3 for ventilated Primary Gravity Thickeners.

Primary sludge pump stations and thickened primary sludge pump stations carry liquid that may evolve flammable gas, but the process medium is non-combustible. Therefore, NH classification applies to pumping system and associated pipework.

5.6.10 Secondary Sludge Thickeners

Secondary sludge is unlikely to form anaerobic conditions and does not normally generate flammable gases in appreciable quantities. Therefore, secondary sludge treatment and pumping systems generally do not need to be classified as hazardous areas.

5.6.11 Anaerobic Digesters and Auxiliaries

Reference shall be made to AS/NZS 60079.10.1: 2009 Classification of areas – Explosive gas atmospheres, ZA.8.3.2.2 and ZA 8.3.2.3.

5.6.12 Drainage Sumps

The following applies to drainage sumps that collect waste from anaerobic digesters:

- Zone 1 classification within the sump, where digester waste has the potential to evolve flammable gases that are heavier than air and are not being dispersed.
- Zone 2 classification surrounding the top of a sump.

Drainage sumps associated with other sludge treatment systems, such as Primary Sludge (PS), Waste Activated Sludge (WAS) or Return Activated Sludge (RAS) shall generally be classified as NH.

5.6.13 Co-digestion

Generally, Hazardous Area classification is not required for co-digestion substrate receival, storage and dosing systems.

This also applies to Trade Waste Receival Stations. However, where a Trade Waste Receival Station has a record of flammable liquids being delivered, areas where the concentration of flammable vapour is likely to exceed 20% of LEL of Methane should be classified by calculation and dispersion modelling.

5.6.14 Digested Sludge Dewatering System

Reference shall be made to AS/NZS 60079.10.1: 2009 Classification of areas – Explosive gas atmospheres, ZA.8.3.3.

In addition:

- Zone 2 classification will apply above the sludge of enclosed feed tanks without ventilation, due to the risk of biogas accumulation.
- NH classification for centrate tanks.
- Zone 2 classification for the inside of dewatering equipment, where gas may accumulate. NH classification otherwise.
- NH classification for dewatering buildings with adequate ventilation.

5.6.15 Digester Galleries and Pipe Galleries

Specific guidance is given for digester galleries in AS/NZS 60079.10.1, section ZA.8. This should generally be referred to.

Additional consideration should be given for locations and scenarios where ventilation is assessed as being inadequate. This may include classifying wider areas within galleries, up to and including the entire gallery area and may include scenarios where forced ventilation systems are not operating. The following principles apply to SA Water assets.

- Zone 2 for the entire gallery ceiling area to 0.5m below the ceiling where ventilation systems are not operating
- Zone 2 for 0.5m radius around pipework extending to the ceiling where good ventilation is demonstrated, i.e. adequate ventilation with duty/standby fan and appropriate alarms and interlocks to ensure continuous operation.

5.6.16 Gas Separation Plants

Gas Separation Plants are installed immediately downstream of sludge anaerobic digesters, with biogas captured in Gas Separation Tanks. Classification shall be similar to Anaerobic Digesters, as follows:

- Zone 0 classification for ullage.
- Zone 1 classification for the interior of venting ducts.
- Zone 1 classification for 0.5m laterally and vertically above manholes.
- Zone 2 classification within a 3m radius of venting duct outlets.

5.6.17 Biosolids Out-loading

Classification as follows:

- NH classification for open area designs.
- NH classification for ventilated enclosures where H_2S monitoring and alarms and interlocks on ventilation failure is available.
- Zone 1 classification for enclosed infrastructure with compromised ventilation.

Hardstand areas for biosolids management is generally classified NH based on SA Water's current design practices.

5.6.18 Powerhouse Battery Rooms

Lead-acid battery systems are able to generate hydrogen gas in the event that the charging voltage exceeds a safe limit. Battery charge voltages are usually prevented from exceeding this limit by the protection features built into the battery charger devices. Where these protection systems exist, the battery rooms may be classified non-hazardous.

5.6.19 Type B Appliances

Type B appliances (as defined in AS 5601) may be classified non-hazardous downstream of their gas inlet isolation valves. Consideration should be given to the design, installation, maintenance and operation of the appliance, and the risk involved when classifying in this fashion. Type B certifications and installation requirements should be documented in the Hazardous Area report and collected as part of the Hazardous Area Dossier.

5.7 Equipment Protection Levels

Equipment protection levels should be assigned according to the hazardous area zones and the relationship shown in AS/NZS 60079.14.

There should be no risk assessment-based reduction in EPLs.

5.8 Documentation

5.8.1 Hazardous Area Report

A hazardous area classification shall be prepared and held in the SA Water Meridian system for each location, describing the hazardous area classification extents and the background information and source data which lead to the classification. Where a modification to a hazardous area occurs, the existing report shall be updated to address the changes.

Included should be information regarding the following:

1. The site location, purpose and background information
2. Materials (gases, liquids and solids) which may contribute to the hazardous area classification
3. Process equipment including identification of sources of release (e.g. pipe flanges, vents, vessels, material containers)
4. Process operating conditions (temperatures, pressures, reactions, concentrations, ventilation qualities)
5. The logical arguments, including calculations and reference to appropriate standards and guides, leading to the type and extent of the hazardous areas.
6. Description of ventilation requirements for rooms protected by artificial ventilation, and associated testing, verification and ongoing operation and maintenance requirements.

The Hazardous area classification report shall include schedules summarising the material properties and the hazardous area zones – example formats are shown in AS/NZS 60079.10.1.

5.8.2 Hazardous Area Drawings

Hazardous area drawings should be clear and unambiguous, showing the zone types and extents. The three-dimensional extents of the zones may be defined simply with annotations to a plan drawing or with elevation and sectional views if necessary. Three dimensional renderings of the zones may be used if they enhance the clarity of the zone extents.

Standard hatching patterns should be used, as shown in AS/NZS 60079.10.1 and 10.2. Variations to the patterns may be used to show specific details (e.g. zones for different gas groups and temperature classes).

Zones should be drafted in red to ensure they are clear and apparent on the drawings.

Notes should be included on drawings that identify hazardous areas and/or classification methods adopted which deviate from standards, such as outcomes from a risk-based approach or conditions assumed for classification, etc.

5.9 Competency

Any design work relating to hazardous areas on SA Water sites shall be undertaken by qualified and competent personnel. Area classification and review should only be carried out by competent persons who have a knowledge and understanding of the process and equipment. Ideally, competent persons performing classifications should possess a minimum of five years of process engineering experience in the water and wastewater industry. This would imply that a team of personnel may be required to provide expertise or requirements in relation to the hazardous area. Competencies shall be in accordance with AS/NZS 4761.1 or attained through the IECEx CoPC scheme with ANZ endorsement.

Where competency is obtained in accordance with AS/NZS 4761.1, units of competency shall be obtained from a nationally recognised Registered Training Organisation. An area classifier must be competent in the following categories:

- Classify areas where flammable gas or vapour hazards may arise
- Classify areas where a combustible dust atmosphere may arise.

Where competency is obtained through the IECEx CoPC scheme, the area classifier shall be competent in the following categories:

Unit Ex 002 – Perform classification of hazardous areas Proof of competence documents, such as course completion certificates, should be submitted with design paperwork for inclusion within the hazardous area dossier.

6 Hazardous Area Compliance - Design, Equipment Selection and Installation

6.1 Design and Selection

6.1.1 General

The objective of this section is to set out the requirements for the design and selection of electrical installations in, or associated with, explosive atmospheres at SA Water facilities. This section supplements and should be read in conjunction with the relevant Australian Standards, specifically AS/NZS 60079.14 and SA Water Technical Standards, TS0300 – Supply and Installation of Low Voltage Electrical Equipment, TS0307 – Fire Detection and Emergency Evacuation Systems and TS0120 – Electronic Security Installation Standards.

6.1.2 Preferred Techniques

Hazardous area compliance can be achieved in a variety of ways, depending on the approach taken and the protection techniques employed. SA Water has preferred design and selection practices with the aim of reducing installation complexity and standardising installation types at their sites.

The primary aim of any design should be to remove the instrumentation or electrical equipment from the hazardous area. If it is possible to design the installation without specifying hazardous area equipment, risk is reduced, installation requirements are less onerous and maintenance requirements are decreased.

Where selection of hazardous equipment is unavoidable, Table 1 should be used as a guide when selecting equipment.

Table 7 - Preferred Protection Techniques

Equipment	Preferred Techniques		
	Zone 0	Zone 1	Zone 2
LV Motors	N/A	Ex e	Ex n
Local Control Stations	N/A	Ex e	Ex e
Junction Boxes	N/A	Ex e	Ex e
HID Luminaires	N/A	Ex de (LED Type)	Ex de (LED Type)
Other Luminaires	N/A	Ex e (LED Types)	Ex e (LED Types)
Transmitters	Ex ia	Ex d	Ex d
I/P Converters	N/A	Ex d	
Solenoids	N/A	Ex me	Ex me
Process Switches	N/A	Ex d	Ex d
Proximity Switches	N/A	Ex i	Ex n
Limit Switch boxes	N/A	Ex d	Ex d
Analysers	Ex ia	Ex ib	Ex ic
Fire Detectors	N/A	Ex ib	Ex ic
Gas Detectors	N/A	Ex d	Ex d

There may be scenarios where a non-preferred protection technique is used after considering additional design considerations. For example, an Ex d device may be selected in preference

to an Ex e device in an area where additional mechanical durability is desirable. Where additional considerations are not required, however, Table 7 should be applied.

With the exception of Zone 0 applications, fire services, analysers and Zone 1 proximity switches, it is SA Waters preference that Ex i installations be avoided. This protection technique adds increased technical complexity to the installation that can be avoided with the use of non-energy limiting protection techniques.

6.1.3 Acceptable Certification

All equipment installed within hazardous areas shall have current IECEx or ANZEx certification. AUSEx is an obsolete certification scheme and shall be avoided for new installations. Although the AUSEx certification system is obsolete, old equipment produced (and certified) under this scheme is still compliant if it was manufactured during the currency of that system and associated certificate. As such, existing AUSEx certified equipment held in SA Water stores may be installed for maintenance purposes.

AS/NZS 60079.14 allows for foreign certified equipment to be installed as long as it can be demonstrated that the equipment affords an equivalent or better level of safety as an IECEx certified item of equipment. This approach shall be limited to where it is not possible to select an IECEx or ANZEx certified item of equipment and contingent upon it passing a conformity assessment.

If a conformity assessment is necessary, then the assessment and supporting Conformity Assessment Document (CAD) shall be provided by an assessor holding the competency unit 'Conduct a Conformity Assessment of Explosion Protected Equipment' in accordance with AS/NZS 4761.1 and shall include:

1. Executive summary
2. Scope
3. Equipment application
4. Description
5. Function of the product including location
6. Clause by clause comparison of the foreign certification standards to the required Australian Standards for compliance and testing, demonstrating an equivalent of better level of safety is afforded by the equipment than is required by the Australian Standards
7. Manufacturer supplied documentation
8. Training required of installation and maintenance personnel
9. Statement of assessment of conformity including special requirements to be observed
10. Authorisation of the report
11. Conclusion – including statement of assessor of positive or negative conclusion

6.1.4 Compliance to Standards at Time of Installation

It is required that an installation is compliant to the standards of the day. As such, if Australian Standards are updated, there is a chance that an existing installation may not comply with the current standards even if it was compliant at the time of installation.

It can be difficult to ascertain the date of manufacture of equipment, therefore where there are known instances where the installation was compliant at the time of installation, and that the current standards have varied, then this shall be recorded in the verification dossier such that it is evident to the reader that the specific item of equipment is compliant.

6.1.5 Materials of Construction

Materials of construction are particularly significant for equipment installed in hazardous area installations because the consequences of equipment failing can be catastrophic. In addition to this, equipment that deteriorates over time will fail mandatory hazardous area inspections and therefore require replacement. The following requirements shall be adhered to:

1. Specification of non-corrosive instrumentation where H_2S is present.
2. Materials of construction shall be appropriate for the installation environment
3. Preference for 316 stainless steel fixings and supports
4. Polycarbonate type boxes to be avoided where exposed to UV
5. Where equipment is subject to prolonged humidity and wide temperature variations that may lead to condensation affecting the type of protection the equipment should be provided with suitable measures to ensure satisfactory prevention of condensation or draining of any condensate.

6.1.6 Non-Hazardous Rated Equipment Requirements

To prevent confusion, hazardous area certified equipment shall not be installed within areas that are not classified as hazardous areas.

As a rule of thumb, non-hazardous rated equipment should not be installed within 500mm of a classified hazardous area where possible.

6.1.7 Ambient Temperature

When selecting equipment, the ambient temperature conditions shall be taken into account. This not only includes environmental conditions, but also process temperatures or solar radiation.

HA Equipment installed in direct sunlight shall be rated for minimum 50°C ambient temperature and also is to be provided with a sunshade to prevent direct sunlight.

6.1.8 Electrical isolation

It is required that there is a means to isolate all equipment located in hazardous areas for the purposes of maintenance, emergency and functional switch-off.

For low voltage circuits, means of isolation is required in all active conductors, including the neutral. The isolating device shall incorporate switching such that all conductors are isolated simultaneously. This isolating device shall be located in a non-hazardous area.

Consideration shall be given to functional isolation for switch-off, as well as targeted isolation for maintenance requirements.

6.1.9 Unused cores

Where multi core cables are used in hazardous areas, spare cores must be terminated.

For non-intrinsically safe circuits, cores must be terminated at both ends and earthed at one end, preferably at the non-hazardous area end. Spare cores shall be terminated in fixed terminals (not 'blue pointed').

For intrinsically safe circuits, spare cores shall be terminated but not earthed at both ends, unless it is a multicore cable where some cores are inherently earthed via the associated apparatus. For this scenario, all spare cores shall be earthed at one end to the same apparatus earth.

It is often difficult to suitably terminate spare cores in an end device, therefore cabling to end devices shall be designed and installed such that there are no spare cores.

6.1.10 Cable selection

Cabling systems shall be selected in accordance with the AS/NZS 60079.14. In addition to this, the following shall be adhered to:

1. As a preference, all cabling installed in or traversing zone 0 or zone 1 (or zone 20 or zone 21) installations shall be Steel Wire Armoured (SWA).

   Note: SWA cable is not mandated by Australian Standards, however, mechanical protection is required for Zone 1 and Zone 2 applications (refer to AS/NZS 60079.14 Appendix ZZ,Table 9.3.2.3). When installing other mechanical protection e.g. conduit, care must be taken to enclose all bends and to continue the protection right up the equipment, which is often difficult to achieve and also to disassemble for maintenance. Conduit can also cause confusion for inspectors as it is not visually evident whether the conduit requires to be certified, or whether the conduit is in place for mechanical protection only. For these reasons, SWA cabling shall be used as a preference.

2. The requirements for mechanical protection in zone 2 (and zone 22) are less onerous and therefore SWA cabling is not mandated. Although not mandated by the Australian Standards, it is preferred that for new installations, SWA cabling is used in zone 2. This reflects the industrial nature of many SA Water sites and provides an additional level of protection for these installations.

3. Cabling installed in direct sunlight shall be UV stabilised.

4. For intrinsically safe cabling:

   a. Cable sheathing shall be blue (Note, that if cabling cannot be procured that meets all technical requirements as well as being blue, then other colour cabling may be installed. If this is the case, then the cable shall be heat-shrinked blue for 300mm at each end and additional cable labels fitted identifying 'INTRINSICALLY SAFE CIRCUIT'.)

   b. Insulation shall be rated to a minimum of 500VDC

   c. To ensure separation of intrinsically safe and non-intrinsically safe circuits both at the time of installation and into the future, all intrinsically safe cabling shall be Steel Wire Armoured.

   d. Multi-core intrinsically safe cables shall not contain non-intrinsically safe circuits.

6.1.11 Calculations

6.1.11.1 EX E

Where Ex e protection methods are employed, it may be necessary to perform a Maximum Dissipated Power (MDP) calculation. This requirement applies to Ex e junction boxes used for the junction and termination of LV power cables to equipment. Where the conductors are sized in accordance with the requirements of the Ex e certification documents, then no further calculations are required.

Where sizing information is not available within the certifying documents, cable configurations shall be determined in accordance with AS/NZS 3008.1.1 as if they are "three conductors in conduit in air". MDP calculations shall be performed using the rating of the cable protection device, not the rating of the cable.

6.1.11.2 EX I

Although Intrinsically Safe circuits are not a preferred protection method at SA Water sites, there may be times where this technique is required, such as in Zone 0 or Zone 20 environments and where analysers are required. Where Ex i protection methods are employed, it may be necessary to perform an IS calculation to confirm the suitability of the device / cable / IS barrier

combination. IS calculations shall be included in the dossier, in combination with the certificates for the associated devices.

Note: There are some instances where a device / cable / IS barrier combination are type-matched, and this will be indicated on the associated documentation. When this is the case, no additional IS calculation is required.

6.1.12 Competency of Designers

Any design work relating to hazardous areas on SA Water sites shall be undertaken by qualified and competent personnel. Competencies shall be in accordance with AS/NZS 4761.1 or attained through the IECEx CoPC scheme with ANZ endorsement.

Where competency is obtained in accordance with AS/NZS 4761.1, units of competency shall be obtained from a nationally recognised Registered Training Organisation. Designers must be competent in the following categories:

- Assess the fitness for purpose of explosion-protected equipment
- Apply explosion-protection requirements to the design of electrical systems and installations

Where competency is obtained through the IECEx CoPC scheme, the designers shall be competent in the following categories:

- Unit Ex 001 – Apply basic principles of protection in explosive atmospheres.
- Unit Ex 009 – Design electrical installations in or associated with explosive atmospheres.

Proof of competence documents, such as course completion certificates, shall be submitted with design paperwork for inclusion within the hazardous area dossier.

6.2 Equipment Installation

6.2.1 General

The objective of this section is to set out the requirements for the installation of electrical installations in, or associated with, explosive atmospheres at SA Water facilities. This section supplements and should be read in conjunction with the relevant Australian Standards, specifically AS/NZS 60079.14 and SA Water Technical Standards, TS0300 – Supply and Installation of Low Voltage Electrical Equipment, TS0307 – Fire Detection and Emergency Evacuation Systems and TS0120 – Electronic Security Installation Standards.

6.2.2 Labelling

Equipment located in hazardous areas shall be clearly labelled with its associated tag number, such that the device can be identified and correlated with its associated documentation in the hazardous area verification dossier (refer section 8 verification dossier requirements). All equipment located on SA Water sites shall be labelled as per the requirements of TS 0133 – Requirements for Asset Labelling.

In addition to TS 0133 requirements, it is required that:

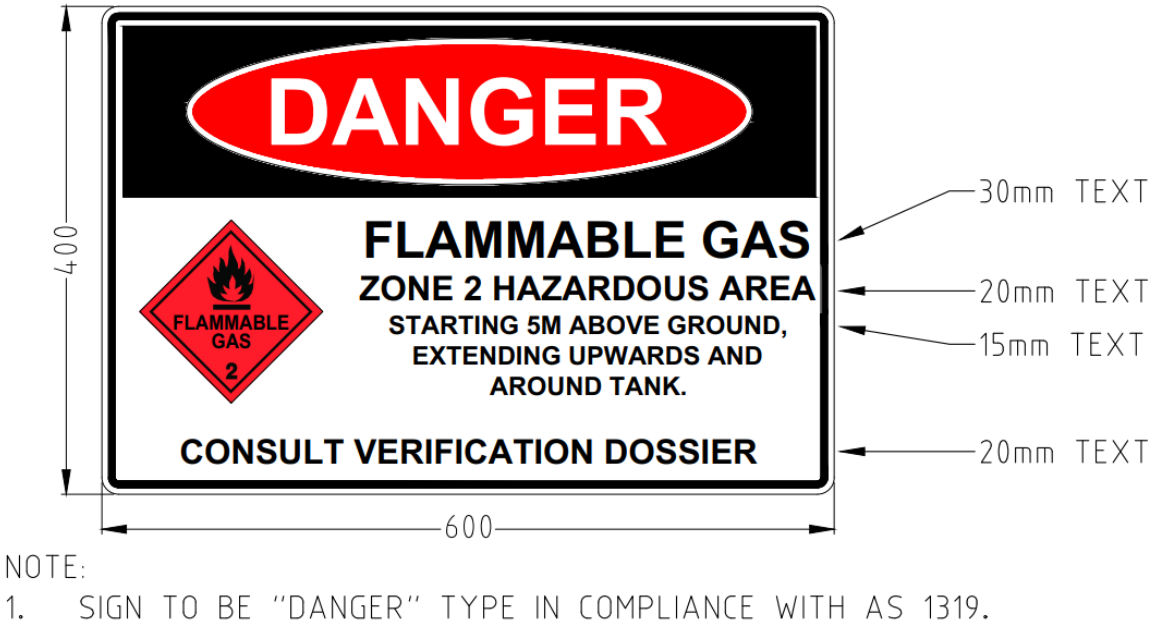
1. All HA equipment cabling is fitted with a cable number adjacent to the equipment;
2. The source of supply can be determined from a drawing or schedule by reference to the tag number or cable number, and;
3. All equipment is clearly and unambiguously shown on a drawing on which the source of supply is either identified directly, or indirectly, via a schedule.

6.2.3 Signage

6.2.3.1 Area Signage

All classified hazardous areas shall be signed accordingly. Signage shall be fabricated in accordance with AS 1319 and match the layout shown in Figure 3. The signs shall be 600mm x 400mm and shall include, as a minimum, the following information:

1. "DANGER" – Logo detail per AS 1319 "ZONE x HAZARDOUS AREA"
2. "FLAMMABLE GAS" or "COMBUSTIBLE DUST" as appropriate – 30mm text height
3. "ZONE x HAZARDOUS AREA" – 20mm text height
4. Description of the source of the hazardous area – 15mm text height (min.)
5. "CONSULT VERIFICATION DOSSIER" – 20mm text height "DANGER"



NOTE:
1. SIGN TO BE "DANGER" TYPE IN COMPLIANCE WITH AS 1319.

Figure 3 – Danger Sign Layout

Signs shall be installed such that they prominently indicate the presence of hazardous areas. Each sign shall be installed approximately 1400mm from the ground, not be obstructed from vision and located in a well-lit area. Signage should be located at all foreseeable approach ways to a hazardous area. Signage shall not inhibit maintenance access for pipe work or electrical installations. Sign edges shall not create a potential injury hazard by protruding into walkways.

Signage shall be fixed using 316 stainless steel fixings. Where not possible to screw into a concrete wall, permission may be sought to use an alternative method. Some sign locations may require a ground-mounted stand. The mounting frames shall be constructed of 316 stainless steel. Each frame shall be situated where it can be bolted into concrete.

6.2.3.2 Gas Migration Signage

There are many instances at SA Water sites where penetrations through walls have been sealed specifically to prevent gas migration. These instances shall be labelled: "Wall penetration sealed to prevent gas migration from this hazardous area as per AS/NZS 60079.14. Consult verification dossier". The labels shall be mounted on walls or ceilings using 316 stainless steel screws.

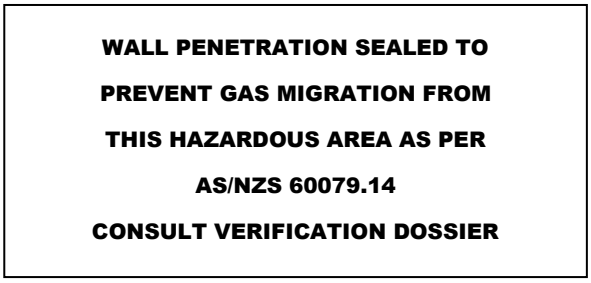


Figure 4 – Wall penetration labelling

6.2.3.3 Marking for Rooms Protected by Artificial Ventilation

Artificially ventilated rooms shall be marked according to AS/NZS 60079.13. Signs shall be posted at a readily visible location mounted on walls or ceilings using 316 stainless steel screws.

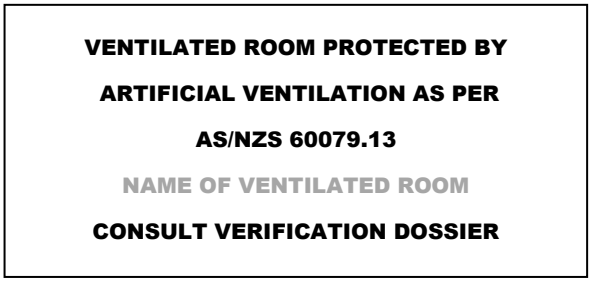


Figure 5 – Ventilated room labelling

Critical technical information such as groups and temperature class of equipment, volume of ventilated room, minimum purge flow and duration, and required minimum artificial ventilation flow rate shall be easily identifiable from the signage.

Where purging is required, the isolating switch shall be clearly marked with warnings for minimum purging time required according to AS/NZS 60079.13.

Where the position of a door is significant with respect to the ventilation performance, a warning sign shall be mounted on the inside and outside to 'keep door closed' according to AS/NZS 60079.13.

6.2.4 Potential Equalisation and Bonding

All equipment installed in hazardous areas needs to be equipotentially bonded to mitigate sparking due to differences in electrical potential. Equipotential bonding of equipment in hazardous areas can be achieved in a number of ways. The strategy is dependent on the type of structure to which the device is fixed.

For skid-based equipment, or equipment fixed to a metallic structure, if the skid or structure is effectively earthed, then supplementary bonding may not be required. If the decision is made not to attach supplementary bonding conductors, then the resistance to earth must still be verified by measurement. The resistance must be measured to be < 10 ohms. To prevent charge accumulation, AS 1768 requires a minimum resistance to earth of 1 MOhm, however, in practice, resistance to earth is generally very low (close to 0 Ohm) or very high (close to infinite Ohm), therefore 10 Ohm is specified as practical benchmark to verify that there is good conductivity to earth (to equalise potential).

For many SA Water sites, equipment is mounted to equipment fixed to concrete, and therefore potential can vary. For these instances, installation of supplementary earthing conductors is required. Where there are clusters of equipment and/or instruments, then equipotential earth bars shall be installed with all instruments/equipment bonded to the area equipotential earth

bar. There shall also be a single, continuous earth bonding conductor (minimum 10mm^2 earth) between this earth bar and the main earth.

Supplementary bonding conductors shall be a minimum of 6mm^2 PVC/PVC earth cable.

Bonding may be achieved via SWA cable correctly terminated in a SWA gland at both ends.

6.2.5 Cable support

Good practices should be followed when supporting cables, to minimise cable damage and to allow inspections to be carried out (which may require inspection of the glands) without degrading the installation. The following requirements are to be adhered to:

1. Cables shall be installed with a service loop at the field device. Loops are to be a minimum of 150mm in diameter, or the required bending radius of the specific cable, whichever is greater.
2. Cables shall be suitably supported to within 300mm of the end of the terminating cable gland. Support shall be by means of specific conduit and cable supports for the installed device and shall not be supported via fixings to process tube or pipework.
3. Cables shall be installed such that there is no lateral tension applied to the terminating cable gland. Bending radius must start a minimum of a 25mm away from the end of the gland.
4. Where conduit is utilised to support cables, the conduit should be treated as a cable support and/or mechanical protection only and should not form part of the Ex protection. As such, open ended conduits should be used. Note that Y seals may be required to prevent gas migration across zone boundaries.
5. The use of certified flexible metal conduit systems is not preferred.

6.2.6 Gland selection

6.2.6.1 General

Glands shall be selected that maintain the integrity of the protection type and the IP rating of the associated device. It may be necessary to fit an IP washer to the male thread of the gland to maintain IP. Preference is given to selecting a gland that has an identical protection technique as the associated device, however if this is not an option, gland types may be selected in accordance with AS/NZS 60079.14 Table 10.

The use of sealing tape, heat-shrink tube or other materials is not permitted to make the cable fit the gland.

Every cable shall have a dedicated gland (multiple cables per gland are not permitted).

6.2.6.2 Blanking Elements and Adaptors

Blanking elements and adaptors shall be certified for the appropriate Ex protection technique as per the same requirements for glands and equipment. If a piece of equipment is certified by the manufacturer with non-certified glands, blanking plugs and/or adaptors, then it is preferred that they are changed to certified components. This removes ambiguity during subsequent HA inspections.

6.2.6.3 Compound Filled Barrier Glands

AS/NZS 60079.14 has specific criteria to determine when a compound filled barrier gland is required or when a compression gland will suffice. This determination considers issues including whether the cable is substantially circular, largely compact, non-hygroscopic and with non-wicking fillers. Due to difficulties establishing the above conclusively and to remove ambiguity, the following requirements apply:

1. All Ex d flameproof cable glands shall be compound or resin filled barrier type glands.
2. If equipment is connected to a process where the flammable gas is pressurised (gas pipework and associated equipment), then the glanding shall be compound filled barrier type, regardless of which type of Ex protection. Note, instruments that are separated from the process with a thermowell are excluded from this requirement.

6.2.6.4 EX I Intrinsic Safety

For cables that contain a single intrinsically safe circuit, there are no specific requirements for cable glands except that it maintains minimum IP20. However, the gland should be selected to be suitable for the environment in which it is installed. Where a gland is attached to a metal device, the preference is for a mechanically robust metal IP gland to be installed.

For cables that contain multiple intrinsically safe circuits, the cable gland shall be selected in accordance with AS/NZS 60079.14 Table 10.

6.2.7 Hazardous Area Zone Boundaries

The below requirements are specific to the 500mm, Zone 2, hazardous area across the ceiling of galleries and basements containing gas pipe work in Wastewater Treatment Plants. Wall mounted conduit shall not traverse a hazardous area boundary.

The figure below depicts how wall mounted conduit systems which enter or leave a hazardous area shall be installed incorporating a 100mm break in the conduit where is traverses the hazardous area. Each end of the conduit system shall be left open to atmosphere to prevent gas migration. A saddle shall be installed to retain the cable in the open section.

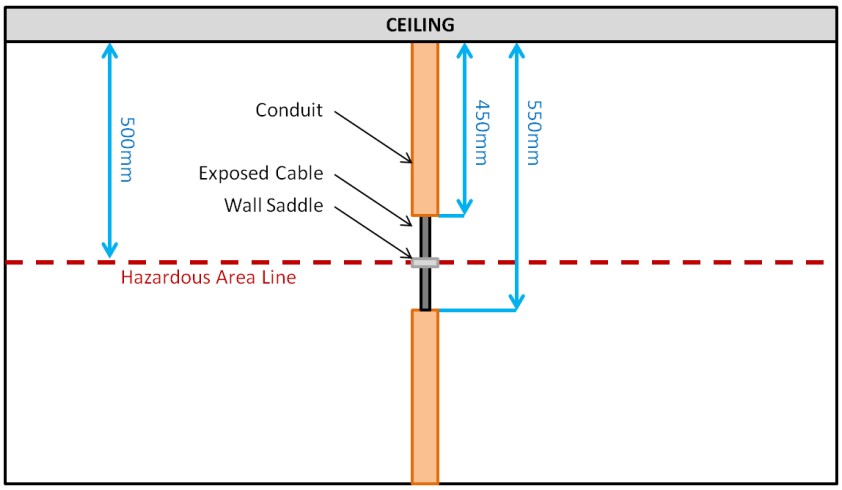


Figure 6 - Conduit Traversing Hazardous Area

Labelling shall be fitted to identify that the conduit break is deliberate and required: "Break in conduit to prevent flammable gas migration. Hazardous Areas. As per AS/NZS 60079.14. Consult verification dossier".

Figure 7 - Conduit break across HA boundary label

6.2.8 Flameproof (Ex d)

For motors powered with a soft starter or variable speed drive, the following applies:

1. The motor and converter have been type-tested for the duty, or;
2. The motor shall be fitted with thermistors. The thermistors shall be directly connected to the soft starter or variable speed drive, if possible. Otherwise the thermistors shall be connected to a suitable relay and hard-wired into the motor tripping circuit (contactor or protective device).

6.2.9 Increased Safety (Ex e)

6.2.9.1 Motors with Converter Supply

For motors powered with a soft starter, the following applies:

1. The motor and converter have been type-tested for the duty, or;
2. The motor shall be fitted with thermistors. The thermistors shall be directly connected to the soft starter or variable speed drive, if possible. Otherwise the thermistors shall be connected to a suitable relay and hard-wired into the motor tripping circuit (contactor or protective device).

For motors powered with a variable speed drive, the following applies:

1. The motor and converter have been type-tested for the duty.

6.2.9.2 Junction Boxes

A Maximum Dissipated Power (MDP) calculation must be performed for every Ex e junction box unless prescribed limitations relating to MDP are provided (by the manufacturer) and adhered to.

6.2.10 Intrinsic Safety (Ex ia/ib/ic)

An intrinsically safe entity parameter calculation must be performed for every intrinsically safe circuit, unless a manufacturer supplied device/isolator/cable combination is used in accordance with the limitations prescribed by the vendor.

For instances where identical instrument and intrinsically safe isolators are used, a single calculation may be produced that identifies the maximum cable lengths permissible. All associated instrument tag numbers shall be included in the calculation.

Galvanic isolators shall be selected preferentially over Zener barriers. Zener barriers shall only be used when a specific item of equipment requires it.

For in-switchboard wiring, the following is required for intrinsically safe circuits:

1. All intrinsically safe wiring should be run in separate slotted duct to non-intrinsically safe wiring.
2. Intrinsically safe wiring shall be enclosed in blue slotted duct (non-intrinsically safe wiring should be in slotted duct that is not blue)
3. Equipment with intrinsically safe terminations (intrinsically safe isolators or terminals) shall be spaced a minimum 50mm away from non-intrinsically safe equipment.
4. Flexible conduit shall be fitted to intrinsically safe wiring inside a switchboard, between the gland and the slotted cable duct, where the cabling is not separated from non-intrinsically safe circuits.
5. Labelling (engraved multi-layered Phenolic plastic sheet, such as Gravoply, Rowmark, or approved equivalent in accordance with Technical Standard TS0300) shall be fitted

adjacent to components and on slotted cable duct lids to identify "INTRINSICALLY SAFE CIRCUITS"

6.2.11 Special Installations – Fire Detection Circuits

The equipment available for fire detection is quite limited when Ex certified equipment is required. Therefore, the Ex protection type and method of installation does not necessarily align with the preferred arrangements specified in the preceding sections.

The following are typical characteristics of Ex rated fire detectors:

1. Fire detectors typically utilise intrinsic safety as their form of Ex protection.
2. Fire detectors are looped together.

Appendix 1 Fire Service Requirements provides a strategy for hazardous area compliance of fire detectors.

6.2.12 Competency of Installers

Any installation work relating to hazardous areas on SA Water sites shall be undertaken by or under the close supervision of a qualified and competent personnel.

Close supervision shall mean that the work undertaken by the supervised person shall be fully inspected by the supervisor prior to sign off and energization. The supervisor must hold a formal competency as described below. The supervisor shall accept the supervised persons work as if it were their own and complete all HA documentation for the work (e.g. a detailed Hazardous Area Inspection Sheet).

Competencies shall be in accordance with AS/NZS 4761.1 or attained through the IECEx CoPC scheme with ANZ endorsement.

Where competency is obtained in accordance with AS/NZS 4761.1, units of competency shall be obtained from a nationally recognised Registered Training Organisation. An installer must be competent in the following categories:

- Enter a classified hazardous area to undertake work related to electrical equipment;
- Determine the explosion-protected requirements specified for a classified explosive atmosphere; and
- Install explosion-protected equipment and associated apparatus and wiring.

Where competency is obtained through the IECEx CoPC scheme, the designers shall be competent in the following categories:

- Unit Ex 000 – Basic knowledge and awareness to enter a hazardous area site
- Unit Ex 003 – Install explosion protected equipment and wiring systems.
- Unit Ex 008 – Perform detailed inspection of electrical installations

Proof of competence documents, such as course completion certificates, shall be submitted along with "Initial – Detailed" Hazardous Area Inspection Sheets for inclusion within the hazardous area dossier.

7 Inspection and Testing

7.1 General Inspection Requirements

Hazardous area inspection sheets shall be provided to SA Water in electronic format. The use of digital tools (e.g. tablet) is preferred.

The submitted inspection sheets shall be in an electronic file format that is readable using commonly used software programs (e.g. Pdf file).

7.2 Safety During Inspections

Digital inspection aids should be certified for use in a hazardous area as a preference. If IS certified equipment is not available then a hot work permit is required, as well as the use of a personal gas detector.

The same is required for personal electronic devices (e.g. Mobile phones and smart watches).

7.3 Inspections

All items of electrical equipment located in hazardous areas is required to be inspected initially and periodically, as well as when any modification or overhaul is conducted. The following sections identify specific requirements relating to hazardous are inspections.

9.3.7Appendix C contains sample hazardous area inspection sheets for Ex d, Ex e, Ex i and Ex tD protection techniques. Sub-contractor inspection sheets may be used in lieu of the sample sheets provided as long as they comply with the requirements of AS/NZS 60079.17.

7.3.1 Inspection of New Installations

Every new piece of equipment installed in a hazardous area shall have an initial detailed inspection completed. Any defects identified during the inspection shall be addressed prior to energisation.

7.3.2 Periodic Inspection of Existing Installations

Equipment located in hazardous areas requires periodic inspection to verify the integrity of the equipment. All equipment installed in hazardous areas shall be inspected ('close' grade inspections) at maximum intervals of 4 years. This shall be the default inspection interval. Where equipment shows signs of accelerated degradation, inspection intervals shall be increased in frequency and/or grade of inspection increased to 'detailed', to mitigate the chance of unsafe equipment being in service.

A preferred inspection schedule strategy is to divide the site up into 4 approximately equal areas (arbitrary areas), and to inspect one area each year. This has a couple of benefits:

1. The quantity of items to inspect is more manageable, particularly for large sites; and
2. The site remains cognisant with the requirements to perform inspections.

Note: The above strategy may not be practical for a small site, in which all items could be inspected at the same time every 4 years.

Care should be taken to inspect appropriately to the relevant standards of the day for each item of equipment.

Where hazardous area credentials are no longer visible due to UV damage or other degradation, it is acceptable to reference the existing dossier to determine the hazardous area credentials of the device. If any ambiguity exists regarding the Ex credentials of an item of equipment, then it shall be treated as being non-compliant.

7.3.3 Inspection after Maintenance

Any equipment that is modified as part of any maintenance or repair shall have a 'detailed' grade level of inspection performed prior to re-energisation.

7.3.4 Non-Conformances

For any non-conformances identified during hazardous area inspections, defects should be captured on a defects register, for tracking purposes.

Each defect shall be categorised as per the following:

Table 8 - Defect Priority Rankings

Priority Risk Ranking	Defect Description	Maximum Rectification Time
1	High Safety Defect	Action Immediately
2	Medium Safety Defect	12 Months
3	Low Safety Defect	Prior to Next Inspection

With the following definitions:

Priority 1 – High safety defect:

This priority includes any equipment or installation installed in a hazardous area zone 1 or zone 0, where the defect significantly diminishes or voids the electrical protection and poses a likely or almost certain likelihood for an unsafe incident with critical consequences to occur. SA Water shall be notified as soon as the defect is identified so that actions can be promptly initiated, including consideration being given to taking the defective equipment out of service until rectification can be completed.

Priority 2 – Medium safety defect:

This priority includes any equipment or installation installed where the defect diminishes the electrical protection and poses a possible likelihood for an unsafe incident with major consequences to occur.

Priority 3 – Low safety defect

This priority includes equipment and installations that have defects which do not affect the electrical protection, but are not compliant to company or Australian Standards. Defects may typically be to do with identification missing, securing equipment, documentation incomplete, etc.

7.3.5 Competency

Any Inspection work relating to hazardous areas on SA Water sites shall be undertaken by qualified and competent personnel. Competencies shall be in accordance with AS/NZS 4761.1 and shall be obtained from a nationally recognised Registered Training Organisation.

Installers must be competent in the following categories:

- Enter a classified hazardous area to undertake work related to electrical equipment
- Determine the explosion-protection requirement specified for a classified explosive atmosphere
- Conduct visual and close inspection of electrical installations for hazardous areas
- Conduct detailed inspection of electrical installations for hazardous areas

Proof of competence documents such as course completion certificates shall be submitted with inspection and maintenance paperwork for inclusion within the hazardous area dossier.

8 Maintenance, Overhaul, Modification and Repair

8.1 General

It is important to make the distinction between standard maintenance activities and overhaul or modification activities. Each of these activities requires different skills and competencies. Consequently, persons able to complete maintenance activities may not be competent to complete overhaul or modification of a hazardous rated device.

8.2 Maintenance

SA Water references AS/NZS 3800, as it defines maintenance activities. Maintenance is considered to consist of routine actions taken to preserve the fully serviceable condition of the installed equipment.

SA Water interprets AS/NZS 3800 to mean that like for like replacement of readily removable parts can be undertaken by suitably competent personnel.

Examples of maintenance activities include:

1. Like for like replacement of:
    a. DIN terminals within a junction box
    b. Bolts
    c. Gaskets
    d. Luminaire bulbs and tubes
    e. Integrated circuit boards where all connection points are screw terminal type (i.e. no soldering is required)
    f. Glands, plugs and adaptors suitable for use with the existing protection technique and/or cable construction.
2. All general calibration activities, such as adjusting or confirming temperature, pressure and flow set points with calibrated test equipment suitable for the task
3. Opening of devices to complete detailed grade inspections

8.3 Overhaul, Modification and Repair

Where equipment is damaged or develops a fault that requires overhaul, modification or repair that may impact the protection technique of the device, due consideration must be given to the way in which the work is undertaken. Typically, the competencies and skill sets required to undertake these activities are outside of those held by SA Water personnel and require specialist expertise in a certified and recognised workshop.

Equipment that has been overhauled, modified or repaired shall be marked as such by means of a durable label displayed in a prominent location on the device. The marking shall be as per the following example.

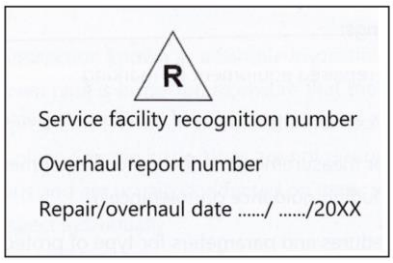


Figure 8 - Overhaul or modification marking label

Examples of overhaul, modification and repair include:

- Additional entries into Ex d type junction boxes
- Replacement of a component on an integrated circuit board requiring soldering
- Motor rewinds
- Bearing replacement
- Refinishing of damaged flame paths

Overhaul, modification and repair can only be undertaken by a certified and registered workshop. The certified workshop shall provide a repair and overhaul report that is numbered as per the repair label attached to the device. This report shall be included in the site dossier along with the original certification for the device. An initial detailed inspection shall be carried out once the overhauled, modified or repaired device is re-installed in the hazardous area.

8.4 Competency

Any maintenance or overhaul work relating to hazardous areas on SA Water sites shall be undertaken by qualified and competent personnel. Competencies shall be in accordance with AS/NZS 4761.1 and shall be obtained from a nationally recognised Registered Training Organisation.

Maintainers and Overhaulers must be competent in the following categories:

- Enter a classified hazardous area to undertake work related to electrical equipment
- Determine the explosion-protection requirement specified for a classified explosive atmosphere
- Conduct detailed inspection of electrical installations for hazardous areas
- Supervise repair and overhaul of explosion-protected equipment. Endorsed for each equipment type.

Proof of competence documents such as course completion certificates shall be submitted with maintenance, overhaul and inspection paperwork for inclusion within the hazardous area dossier.

9 Verification Dossier Requirements

9.1 General

Each site shall have a hazardous area verification dossier, as required by AS/NZS 60079.14. The purpose of the verification dossier is to document all aspects of the classified hazardous area, including classification report and hazardous area zone drawings, equipment register, equipment credentials and inspection records.

There shall be one hazardous area verification dossier for each site. HA documentation provided for a project shall be incorporated into the site verification dossier.

Where a modification occurs in a hazardous area, the existing Hazardous Area Classification Report and drawings shall be updated to reflect these changes.

9.2 Format

The verification dossier shall be in electronic format. It is permissible to have a hard copy printed out for reference; however, the electronic copy shall be maintained as the master dossier. The electronic dossier should have the following characteristics:

1. It shall be viewable by typically available software programs, e.g. 'pdf' file format.
2. The dossier should preferably be consolidated into a single electronic file for ease of file management.
3. The dossier shall be intuitive to navigate such that it is simple to search for a specific item and quickly reference all of its associated credentials and supporting documentation (certificates of conformity, calculations, inspection sheets, etc).

9.3 Documentation Required

The following documentation shall be included in the site hazardous area verification dossier. This can be clarified through a typical table of contents for a Hazardous Area Verification dossier is as such:

- Site / Area Overview Document
  - Statement of plant ownership and operator
  - Description of site or area
  - Description of environmental and other external influences (e.g. ambient temperature)
- Classification Documentation
  - Classification Report
  - Classification Drawings
- EPL Assessment or assessment of consequences of ignition (Optional)
- Ex Equipment Register
  - See Section 9.3.2
- Electrical Drawings (Optional)
- Process Drawings (Optional
- Hazardous Area Inspection Sheets (Latest completed)
- Calculations

    - See Section 9.3.2
    - Ex i Calculations – Intrinsically Safe Circuit Calculations
    - Ex e Calculations – Maximum Dissipated Power (MDP) Calculations
    - Ex p Calculations – Pressurised Enclosure Calculations
- Equipment Certification
    - Certificates of Conformity
    - Conformity Assessment Documents
- Vendor Datasheets and Equipment Technical Documentation (Optional)
- Personnel Details and Records of Competency
    - Designers
    - Installers
    - Maintenance Personnel
    - HA Inspectors

9.3.1 Hazardous Area Classification Report

The hazardous area classification report details the basis of the hazardous area classification. The minimum requirements for inclusion in the classification is described in section 4.7.1 Hazardous Area Report.

This document is used to communicate the decision-making process when determining the extents of hazardous areas throughout the site.

All models and calculations used for the classification of hazardous area shall be supplied to SA Water and included in the Hazardous Area Classification Report, including native files and shall be the property of SA Water.

9.3.2 Ex Equipment Register

The Ex equipment register is a listing of all items of equipment installed within classified hazardous areas at a site.

It is used as a concise reference of all installed equipment and the associated information that justifies compliance to the classification.

It shall include the following information:

1. Equipment tag number
2. Equipment description
3. Equipment manufacturer, model and part number
4. Equipment plant location
5. Details of the area classification where the item is installed: zone, gas group, temperature class
6. Details of the Ex credentials of the item: Ex protection technique, gas group suitability, temperature class, IP rating.
7. Certificate of conformity (certificate number)
8. Associated calculations (reference to calculation number)
9. Hazardous area inspection sheet (reference to the inspection sheet)
10. P&ID (drawing number)

11. Electrical drawing showing point of isolation (drawing number)
12. Details of artificial ventilation requirements
13. Reference to any other relevant documentation (maintenance overhauls, other)
14. Details of associated device (intrinsically safe isolator)

9.3.3 Completed HA Testing and Inspection Record Sheets

All equipment located in hazardous areas is required to be inspected prior to initial energisation and then periodically thereafter. These inspection sheets record the results of the inspections performed.

9.3.4 Hazardous Area Calculations

Some Ex protection techniques require calculations to be done to verify that the installed equipment will operate within the bounds of that technique. Specifically, these are intrinsically safe entity parameter calculations and Ex e junction box maximum dissipated power calculations.

Where these calculations are required, they shall be included in the verification dossier.

9.3.5 Equipment Certification

Every item of equipment (except simple apparatus) installed in a hazardous area requires a certificate of conformity (or justification for otherwise). All certificates of conformity or justifications shall be included in the verification dossier.

9.3.6 Records of Competency

Every person involved in classification, design, installation, inspection, maintenance and auditing relating to hazardous areas is required to be competent to do so. Evidence of qualifications shall be included in the hazardous area dossier. Specifically, every name that is included in the verification dossier; for example, on the classification document, inspection sheets, or any other document, should be able to be verified as being competent for that task by inclusion of qualification evidence in the verification dossier.

9.3.7 Maintenance Records

Any modifications or overhauls to items of equipment must be carried out in accordance with AS/NZS 60079.14. Records of modifications and overhauls shall be included in the verification dossier.

Appendix A - Fire Service Requirements

The equipment available for fire detection is quite limited for hazardous areas. Therefore, the Ex protection type and method of installation does not necessarily align with the preferred arrangements specified throughout this document.

The following describes a method to achieve compliance based on typical available fire detection equipment as found at SA Water sites.

Fire detectors commonly utilise intrinsic safety as their form of Ex protection and are typically looped together. They utilise a proprietary communications protocol with addressable fire detectors and break-glass alarm switches. Figure 9 - Fire Detection Circuitry below is a typical sketch of how each type of component connects into the fire circuit.

There are often fire detectors located in non-hazardous areas also, therefore the fire detector circuit trunk cabling is non-intrinsically safe, and intrinsically safe isolators are located in the field as required to create intrinsically safe sections. Note, each string of detectors shall include only one type of detector, intrinsically safe, or non-intrinsically safe. Non-intrinsically safe smoke detectors must not be looped together with intrinsically safe smoke detectors and vice versa.

Referring to the sketch below, the main trunk of the loop (**RED**) runs to junction boxes located on the walls. From these junction boxes, circuits of multiple smoke detectors are connected.

These junction boxes contain intrinsically safe isolators which then loop as an intrinsically safe circuit (**BLUE**) to a number of smoke detectors.

There must be segregation between intrinsically safe and non-intrinsically safe circuits, therefore separate conduits must be installed to each junction box to ensure that these circuits do not share a conduit.

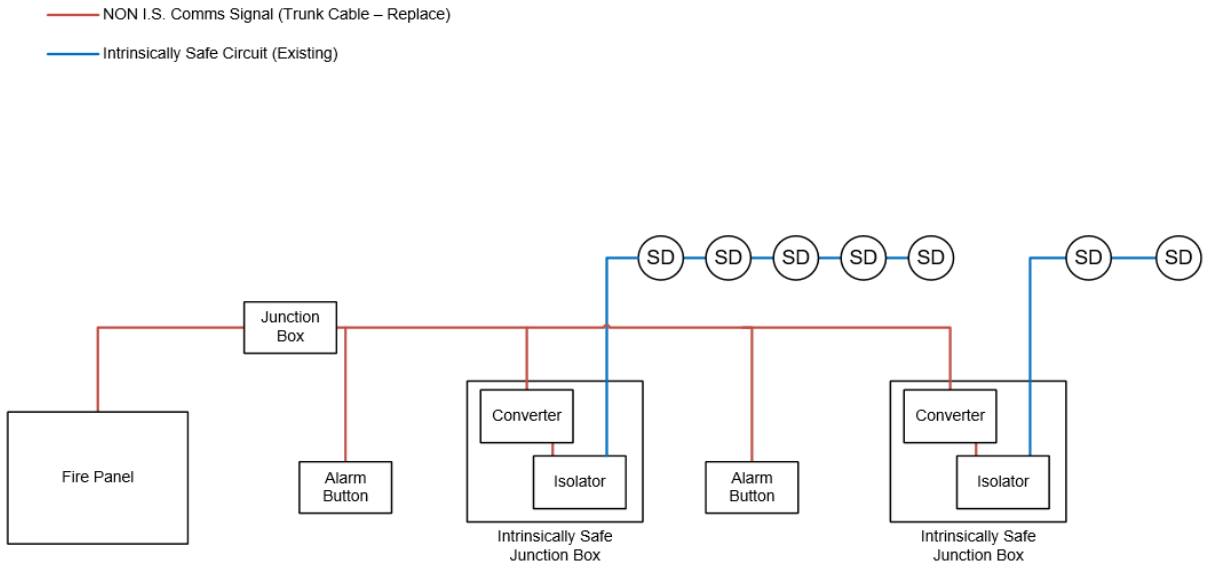
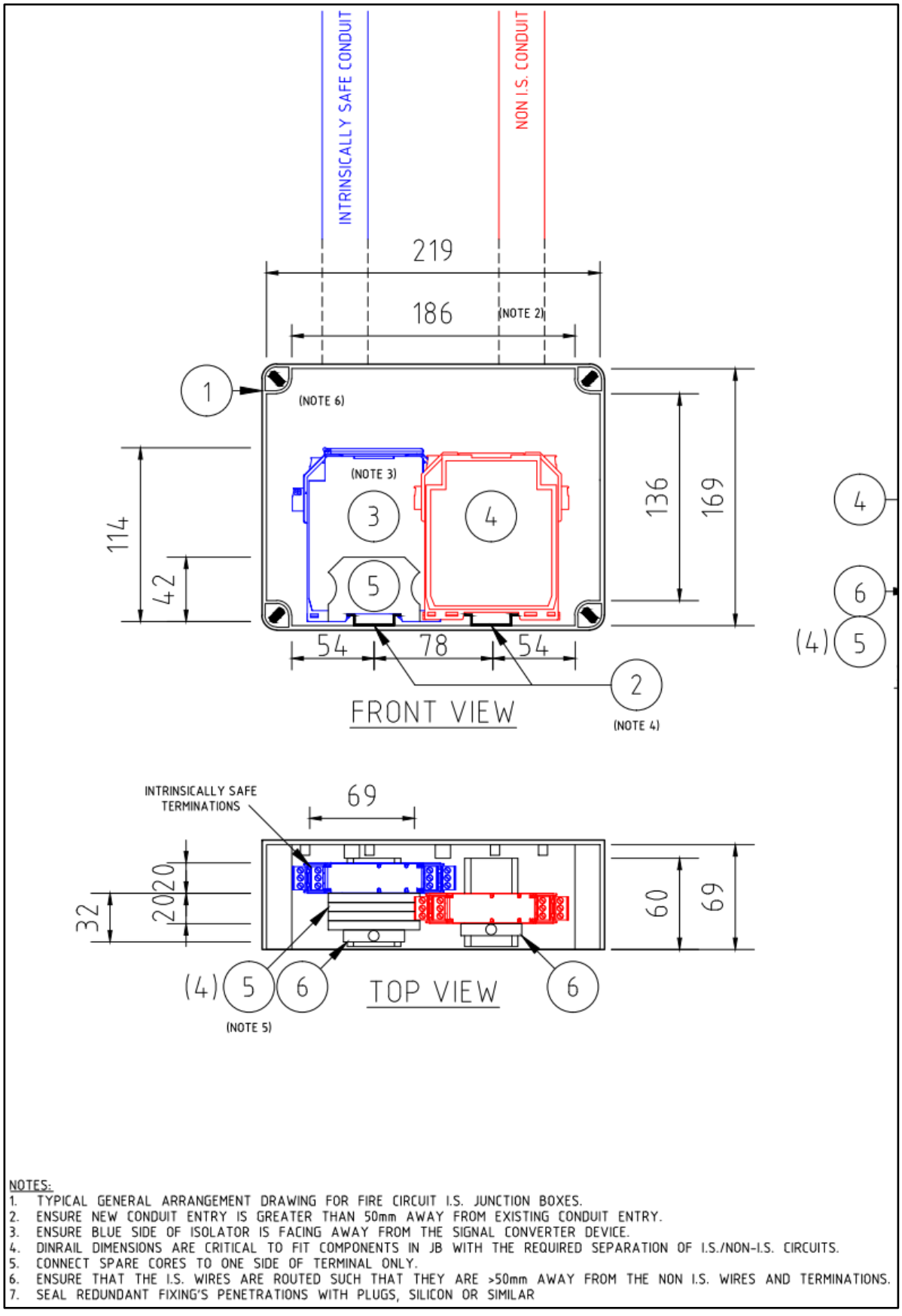


Figure 9 - Fire Detection Circuitry

Segregation of circuits must also be managed within each junction box. Typically, each junction box contains a proprietary signal convertor and an intrinsically safe isolator. The intrinsically safe circuit that connects to the safe side of the intrinsically safe isolator maintain 50mm clearance to all non-intrinsically safe terminations and cabling within the junction box. The drawing below (Bolivar WWTP drawing 2015-00003-51) shows how the equipment should be arranged to achieve the required segregation.



NOTES:
1. TYPICAL GENERAL ARRANGEMENT DRAWING FOR FIRE CIRCUIT I.S. JUNCTION BOXES.
2. ENSURE NEW CONDUIT ENTRY IS GREATER THAN 50mm AWAY FROM EXISTING CONDUIT ENTRY.
3. ENSURE BLUE SIDE OF ISOLATOR IS FACING AWAY FROM THE SIGNAL CONVERTER DEVICE.
4. DINRAIL DIMENSIONS ARE CRITICAL TO FIT COMPONENTS IN JB WITH THE REQUIRED SEPARATION OF I.S./NON-I.S. CIRCUITS.
5. CONNECT SPARE CORES TO ONE SIDE OF TERMINAL ONLY.
6. ENSURE THAT THE I.S. WIRES ARE ROUTED SUCH THAT THEY ARE >50mm AWAY FROM THE NON I.S. WIRES AND TERMINATIONS.
7. SEAL REDUNDANT FIXING'S PENETRATIONS WITH PLUGS, SILICON OR SIMILAR

Figure 10 - Fire Detection - Intrinsically safe circuit segregation diagram

Appendix B - Example Hazardous Areas – Typical Wastewater Treatment Processes

Table 9 - SA Water Sites with Hazardous Areas - Wastewater

Process	Reference Site
Wastewater Network	Hendon
Wastewater Pump Station	PARPS
Treatment Facility Inlet Works	TBA
Foul Air Extraction and OCU	TBA
Primary Sedimentation Tank	Christies Beach WWTP
Primary Sludge Holding Tank	Christies Beach WWTP
Primary Gravity Thickener	Bolivar WWTP
Secondary Sludge Thickener	Pt Lincoln WWTP
Anaerobic Digester and Auxiliaries	Bolivar WWTP
Drainage Sump	Bolivar WWTP
Co-digestion and Trade Waste Receival Station	TBA
Digested Sludge Dewatering System	Bolivar WWTP
Digester Galleries and Pipe Galleries	Bolivar WWTP
Gas Separation Plant	TBA
Biosolids Outloading and Hardstand	TBA

Appendix C - Sample Inspection Sheets

C1 Ex d Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex d – Explosion Proof

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Equipment is appropriate to the EPL/Zone requirements of the location	☐	☐	☐	
A2	Equipment group is correct	☐	☐		
A3	Equipment temperature class is correct (only for gas)	☐	☐		
A5	Degree of protection (IP grade) of equipment is appropriate for the level of protection/group/conductivity	☐	☐	☐	
A6	Equipment circuit identification is correct	☐			
A7	Equipment circuit identification is available	☐	☐	☐	
A8	Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐	☐	☐	
A9	There is no damage or unauthorized modifications	☐			
A10	There is no evidence of unauthorized modifications		☐	☐	
A11	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight				
A11.1	- physical check	☐	☐		
A11.2	- visual check			☐	
12	Threaded covers on enclosures are of the correct type, are tight and secured				
A12.1	- physical check	☐	☐		
A12.2	- visual check			☐	
A13	Joint surfaces are clean and undamaged and gaskets, if any, are satisfactory and positioned correctly	☐			
A14	Condition of enclosure gaskets is satisfactory	☐			
A15	There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	☐			

A16	Dimensions of flanged joint gaps are: - within the limits in accordance with manufacturer's documentation or - within maximum values permitted by relevant construction standard at time of installation	☐			
A24	Breathing operation is satisfactory- (type "nR" only)	☐			
A25	Breathing and draining devices are satisfactory	☐	☐		
	EQUIPMENT SPECIFIC (LIGHTING)				
A27	HID lamps are not indicating EOL effects	☐	☐	☐	
A28	Lamp type, rating, pin configuration and position are correct	☐			
	EQUIPMENT SPECIFIC (MOTORS)				
A29	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks.	☐	☐	☐	
A30	The ventilation airflow is not impeded	☐	☐	☐	
A31	Insulation resistance (IR) of the motor windings is satisfactory	☐			

Device Tag Number

B	INSTALLATION - GENERAL	D	C	V	COMMENTS
B1	Type of cable is appropriate	☐			
B2	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B3	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	☐	☐	☐	
B4	Stopping boxes and cable boxes are correctly filled	☐			
B5	Integrity of conduit system and interface with mixed system maintained	☐			
B6	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductor are of sufficient cross-section)				
B6.1	- physical check	☐			
B6.2	- visual check		☐	☐	
B7	There is no evident damage or degradation that indicates that the fault loop impedance (TN systems) or earthing resistance (IT systems) is not satisfactory	☐			
B8	Automatic electrical protective devices are set correctly (auto-reset not possible)	☐			
B9	Automatic electrical protective devices operate within permitted limits	☐			
B10	Specific conditions of use (if applicable) are complied with	☐			
B11	Cables not in use are correctly terminated	☐			
B12	Obstructions adjacent to flameproof flanged joints are in accordance with IEC 60079-14	☐	☐	☐	
B13	Variable voltage/frequency installation complies with documentation	☐	☐		
	INSTALLATION - HEATING SYSTEMS				
B14	Temperature sensors function according to manufacturer's documents	☐			
B15	Safety cut off devices function according to manufacturer's documents	☐			
B16	The setting of the safety cut off is sealed	☐	☐		
B17	Reset of a heating system safety cut off possible with tool only	☐	☐		
B18	Auto-reset is not possible	☐	☐		
B19	Reset of a safety cut off under fault conditions is prevented	☐			
B20	Safety cut off independent from control system	☐			
B21	Level switch is installed and correctly set, if required	☐			
B22	Flow switch is installed and correctly set, if required	☐			

Device Tag Number

C	ENVIRONMENT	D	C	V	COMMENTS
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**

C2 Ex e Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex e – Increased Safety

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Equipment is appropriate to the EPL/Zone requirements of the location	☐	☐	☐	
A2	Equipment group is correct	☐	☐		
A3	Equipment temperature class is correct (only for gas)	☐	☐		
A5	Degree of protection (IP grade) of equipment is appropriate for the level of protection/group/conductivity	☐	☐	☐	
A6	Equipment circuit identification is correct	☐			
A7	Equipment circuit identification is available	☐	☐	☐	
A8	Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐	☐	☐	
A9	There is no damage or unauthorized modifications	☐			
A10	There is no evidence of unauthorized modifications		☐	☐	
A11	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight				
A11.1	- physical check	☐	☐		
A11.2	- visual check			☐	
A14	Condition of enclosure gaskets is satisfactory	☐			
A15	There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	☐			
A17	Electrical connections are tight	☐			
A18	Unused terminals are tightened	☐			
A20	Encapsulated components are undamaged	☐			
A21	Flameproof components are undamaged	☐			
A24	Breathing operation is satisfactory- (type "nR" only)	☐			
A25	Breathing and draining devices are satisfactory	☐	☐		

	EQUIPMENT SPECIFIC (LIGHTING)				
A26	Fluorescent lamps are not indicating EOL effects	☐	☐	☐	
A27	HID lamps are not indicating EOL effects	☐	☐	☐	
A28	Lamp type, rating, pin configuration and position are correct	☐			
	EQUIPMENT SPECIFIC (MOTORS)				
A29	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks.	☐	☐	☐	
A30	The ventilation airflow is not impeded	☐	☐	☐	
A31	Insulation resistance (IR) of the motor windings is satisfactory	☐			

Device Tag Number

B	INSTALLATION - GENERAL	D	C	V	COMMENTS
B1	Type of cable is appropriate	☐			
B2	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B3	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	☐	☐	☐	
B5	Integrity of conduit system and interface with mixed system maintained	☐			
B6	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)				
B6.1	- physical check	☐			
B6.2	- visual check		☐	☐	
B7	There is no evident damage or degradation that indicates that the fault loop impedance (TN systems) or earthing resistance (IT systems) is not satisfactory	☐			
B8	Automatic electrical protective devices are set correctly (auto-reset not possible)	☐			
B9	Automatic electrical protective devices operate within permitted limits	☐			
B10	Specific conditions of use (if applicable) are complied with	☐			
B11	Cables not in use are correctly terminated	☐			
B13	Variable voltage/frequency installation complies with documentation	☐	☐		
	INSTALLATION - HEATING SYSTEMS				
B14	Temperature sensors function according to manufacturer's documents	☐			
B15	Safety cut off devices function according to manufacturer's documents	☐			
B16	The setting of the safety cut off is sealed	☐	☐		
B17	Reset of a heating system safety cut off possible with tool only	☐	☐		
B18	Auto-reset is not possible	☐	☐		
B19	Reset of a safety cut off under fault conditions is prevented	☐			
B20	Safety cut off independent from control system	☐			
B21	Level switch is installed and correctly set, if required	☐			
B22	Flow switch is installed and correctly set, if required	☐			
	INSTALLATION - MOTORS				
B23	Motor protection devices operate within the permitted T_E or T_A time limits.	☐			

Device Tag Number

C	ENVIRONMENT	D	C	V	COMMENTS
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	
C3	All equipment housings are clean and dry	☐			

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**

C3 Ex n Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex n – Non Sparking

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Equipment is appropriate to the EPL/Zone requirements of the location	☐	☐	☐	
A2	Equipment group is correct	☐	☐		
A3	Equipment temperature class is correct (only for gas)	☐	☐		
A5	Degree of protection (IP grade) of equipment is appropriate for the level of protection/group/conductivity	☐	☐	☐	
A6	Equipment circuit identification is correct	☐			
A7	Equipment circuit identification is available	☐	☐	☐	
A8	Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐	☐	☐	
A9	There is no damage or unauthorized modifications	☐			
A10	There is no evidence of unauthorized modifications		☐	☐	
A11	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight				
A11.1	- physical check	☐	☐		
A11.2	- visual check			☐	
A14	Condition of enclosure gaskets is satisfactory	☐			
A15	There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	☐			
A17	Electrical connections are tight	☐			
A18	Unused terminals are tightened	☐			
A19	Enclosed-break and hermetically sealed devices are undamaged	☐			
A20	Encapsulated components are undamaged	☐			
A21	Flameproof components are undamaged	☐			
A22	Restricted breathing enclosure is satisfactory - (type "nR" only)	☐			

A23	Test port, if fitted, is functional- (type "nR" only)	☐			
A24	Breathing operation is satisfactory- (type "nR" only)	☐			
A25	Breathing and draining devices are satisfactory	☐	☐		
	EQUIPMENT SPECIFIC (LIGHTING)				
A26	Fluorescent lamps are not indicating EOL effects	☐	☐	☐	
A27	HID lamps are not indicating EOL effects	☐	☐	☐	
A28	Lamp type, rating, pin configuration and position are correct	☐			
	EQUIPMENT SPECIFIC (MOTORS)				
A29	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks.	☐	☐	☐	
A30	The ventilation airflow is not impeded	☐	☐	☐	
A31	Insulation resistance (IR) of the motor windings is satisfactory	☐			

Device Tag Number

B	INSTALLATION - GENERAL	D	C	V	COMMENTS
B1	Type of cable is appropriate	☐			
B2	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B3	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	☐	☐	☐	
B5	Integrity of conduit system and interface with mixed system maintained	☐			
B6	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)				
B6.1	- physical check	☐			
B6.2	- visual check		☐	☐	
B7	There is no evident damage or degradation that indicates that the fault loop impedance (TN systems) or earthing resistance (IT systems) is not satisfactory	☐			
B8	Automatic electrical protective devices are set correctly (auto-reset not possible)	☐			
B9	Automatic electrical protective devices operate within permitted limits	☐			
B10	Specific conditions of use (if applicable) are complied with	☐			
B11	Cables not in use are correctly terminated	☐			
B13	Variable voltage/frequency installation complies with documentation	☐	☐		

C	ENVIRONMENT	D	C	V	COMMENTS
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	
C3	All equipment housings are clean and dry	☐			

Device Tag Number

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**

C4 Ex p Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex p – Pressurisation

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Equipment is appropriate to the EPL/zone requirements of the location	☐	☐	☐	
A2	Equipment group is correct	☐	☐		
A3	Equipment temperature class or surface temperature is correct	☐	☐		
A4	Equipment circuit identification is correct	☐			
A5	Equipment circuit identification is available	☐	☐	☐	
A6	Enclosure, glasses and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐	☐	☐	
A7	There is no evident damage or degradation that indicates that the intrinsically safe circuit earthing is not satisfactory	☐			
A8	There is no evident damage or unauthorised modification		☐	☐	
A9	Lamp type, rating, and position are correct	☐			

Device Tag Number

B	INSTALLATION - GENERAL	D	C	V	COMMENTS
B1	Type of cable is appropriate	☐			
B2	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B3	Earthing connections, including any supplementary earthing bonding connections, are satisfactory, for example connections are tight and conductors are of sufficient cross-section - physical check - visual check	☐	☐	☐	
B4	There is no evident damage or degradation that indicates that the fault loop impedance (TN systems) or earthing resistance (IT systems) is not satisfactory	☐			
B5	Automatic electrical protective devices operate within permitted limits	☐			
B6	Automatic electrical protective devices are set correctly	☐			
B7	Protective gas inlet temperature is below maximum specified	☐			
B8	Ducts, pipes and enclosures are in good condition	☐	☐	☐	
B9	Protective gas is substantially free from contaminants	☐	☐	☐	
B10	Protective gas pressure and/or flow is adequate	☐	☐	☐	
B11	Pressure and/or flow indicators, alarms and interlocks function correctly	☐			
B12	Conditions of spark and particle barriers of ducts for exhausting the gas in hazardous area are satisfactory	☐			
B13	Specific conditions of use (if applicable) are complied with	☐			

C	ENVIRONMENT	D	C	V	COMMENTS
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	

Device Tag Number

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**

C5 Ex i Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex i – Intrinsic Safety

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Associated I.S. Barrier / Isolator Details				
I.S Device Type	Barrier ☐	Isolator ☐	Certified with Device ☐	Other ……
Manufacturer:				
Model No.:				
Serial No.:				
Gas Group:				
Temp Class:				
Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)				
Certificate Number:				

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

Device Tag Number

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Circuit and/or equipment documentation is appropriate to the EPL/Zone	☐	☐	☐	
A2	Equipment installed is that specified in the documentation	☐	☐		
A3	Circuit and/or equipment category and group correct	☐	☐		
A4	IP rating of equipment is appropriate to the Group III material present	☐	☐		
A5	Equipment temperature class is correct	☐	☐		
A6	Ambient temperature range of the apparatus is correct for the installation	☐	☐		
A7	Service temperature range of the apparatus is correct for the installation	☐	☐		
A8	Installation is clearly labelled	☐	☐		
A9	Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐			
A10	Cable glands and blanking elements are the correct type, complete and tight - physical check - visual check	☐	☐	☐	
A11	There is no damage or unauthorised modification	☐			
A12	There is no evidence of unauthorized modifications		☐	☐	
A13	Diode safety barriers, galvanic isolators, relays and other energy limiting devices are of the approved type, installed in accordance with the certification requirements and securely earthed where required	☐	☐	☐	
A14	Condition of enclosure gaskets is satisfactory	☐			
A15	Electrical connections are tight	☐			
A16	Printed circuit boards are clean and undamaged	☐			
A17	The maximum voltage U_m of the associated apparatus is not exceeded	☐	☐		

Device Tag Number

B	INSTALLATION - GENERAL	D	C	V	COMMENTS
B1	Cables are installed in accordance with the documentation	☐			
B2	Cable screens are earthed in accordance with the documentation	☐			
B3	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B4	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	☐	☐	☐	
B5	There is no evident damage or degradation that indicates that the point-to-point connections are not correct (initial inspection only)	☐			
B6	Earth continuity is satisfactory (e.g. connections are tight, conductors are of sufficient cross-section) for non-galvanically isolated circuits	☐			
B7	Earth connections maintain the integrity of the type of protection	☐			
B8	There is no evident damage or degradation that indicates that the intrinsically safe circuit earthing is not satisfactory	☐			
B9	Insulation resistance is satisfactory	☐			
B10	Separation is maintained between intrinsically safe and non-intrinsically safe circuits in common distribution boxes or relay cubicles	☐			
B11	Short-circuit protection of the power supply is in accordance with the documentation	☐			
B12	Specific conditions of use (if applicable) are complied with	☐			
B13	Cables not in use are correctly terminated	☐			

C	ENVIRONMENT	D	C	V	COMMENTS
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	

Device Tag Number

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**

C6 Ex t Inspection Sheet Example

Device Tag Number

SA Water – Hazardous Area Inspection Sheet

Ex t – Enclosure

Note to Contractors: Contractors undertaking inspections may use their own inspection sheet template providing the template contains at a minimum the information contained upon this sheet and otherwise satisfies the requirements as stipulated in the latest revision of AS/NZS 60079.17.

Facility:	
Plant Area:	
Equipment Service:	
Electrical and Process Drawings: (As appropriate)	

Apparatus Type:	
Manufacturer:	
Model No.:	
Serial No.:	
IP Class:	

Area Classification		**Equipment Certification**	
Classification Drawing:		**Protection Technique:**	
Zone:		**Gas:**	
Gas / Dust Group:		**Gas / Dust Group:**	
Temperature Class:		**Temperature Class:**	
Environmental Conditions: (E.g. Indoor, Outdoor, Hot, Cold, Dusty, Coastal)		**Certification Scheme: (ANZEz, AUSEx, IECEx, CAD)**	
		Certificate Number:	

Device Tag Number

Cable Entry Components (Glands, Adapters, Reducers, Plugs)				
Type	**Qty.**	**Manufacturer**	**Model**	**Certificate Number**

Inspection Type:	Initial / Construction ☐		Periodic / Maintenance ☐	
Inspection Level:	Detailed ☐	Close ☐	Visual ☐	Continuous (Visual) ☐

A	GENERAL (ALL EQUIPMENT)	D	C	V	COMMENTS
A1	Equipment is appropriate to the EPL/Zone requirements of the location	☐	☐	☐	
A2	Equipment group is correct	☐	☐		
A4	Equipment maximum surface temperature is correct	☐	☐		
A5	Degree of protection (IP grade) of equipment is appropriate for the level of protection/group/conductivity	☐	☐	☐	
A6	Equipment circuit identification is correct	☐			
A7	Equipment circuit identification is available	☐	☐	☐	
A8	Enclosure, glass parts and glass-to-metal sealing gaskets and/or compounds are satisfactory	☐	☐	☐	
A9	There is no damage or unauthorized modifications	☐			
A10	There is no evidence of unauthorized modifications		☐	☐	
A11	Bolts, cable entry devices (direct and indirect) and blanking elements are of the correct type and are complete and tight				
A11.1	- physical check	☐	☐		
A11.2	- visual check			☐	
A14	Condition of enclosure gaskets is satisfactory	☐			
A15	There is no evidence of ingress of water or dust in the enclosure in accordance with the IP rating	☐			
A17	Electrical connections are tight	☐			
	EQUIPMENT SPECIFIC (LIGHTING)				
A26	Fluorescent lamps are not indicating EOL effects	☐	☐	☐	
A27	HID lamps are not indicating EOL effects	☐	☐	☐	
A28	Lamp type, rating, pin configuration and position are correct	☐			

	EQUIPMENT SPECIFIC (MOTORS)				
A29	Motor fans have sufficient clearance to the enclosure and/or covers, cooling systems are undamaged, motor foundations have no indentations or cracks.	☐	☐	☐	
A30	The ventilation airflow is not impeded	☐	☐	☐	
A31	Insulation resistance (IR) of the motor windings is satisfactory	☐			

B	**INSTALLATION - GENERAL**	**D**	**C**	**V**	**COMMENTS**
B1	Type of cable is appropriate	☐			
B2	The cables are adequately supported and there is no obvious damage to cables	☐	☐	☐	
B3	Sealing of trunking, ducts, pipes and/or conduits is satisfactory	☐	☐	☐	
B5	Integrity of conduit system and interface with mixed system maintained	☐			
B6	Earthing connections, including any supplementary earthing bonding connections are satisfactory (for example connections are tight and conductors are of sufficient cross-section)				
B6.1	- physical check	☐			
B6.2	- visual check		☐	☐	
B7	There is no evidence or degradation that indicates that the fault loop impedance (TN systems) or earthing resistance (IT systems) is not satisfactory	☐			
B8	Automatic electrical protective devices are set correctly (auto-reset not possible)	☐			
B9	Automatic electrical protective devices operate within permitted limits	☐			
B10	Specific conditions of use (if applicable) are complied with	☐			
B11	Cables not in use are correctly terminated	☐			
B13	Variable voltage/frequency installation complies with documentation	☐	☐		
	INSTALLATION - HEATING SYSTEMS				
B14	Temperature sensors function according to manufacturer's documents	☐			
B15	Safety cut off devices function according to manufacturer's documents	☐			

C	**ENVIRONMENT**	**D**	**C**	**V**	**COMMENTS**
C1	Equipment is adequately protected against corrosion, weather, vibration and other adverse factors	☐	☐	☐	
C2	No undue accumulation of dust and dirt	☐	☐	☐	
C3	All equipment housings are clean and dry	☐			

Device Tag Number

Device has been verified against the original design. i.e. Datasheet or Ex Register:	☐
Device certificate sited: **Special conditions (if applicable) complied with:**	☐ ☐
Cable entry component (Gland, plug adaptor) certificates sited: **Special conditions (if applicable) complied with:**	☐ ☐
Other certificates sited (list, if any)	

Comments / Observed Defects

Inspector Details	
Inspector Name:	
Company (SA Water or Contractor Company):	
Electrical Licence:	
HA Competency Certificate No.:	
Signature:	**Date:**