HAZARDOUS AREAS FOR WATER & WASTEWATER FACILITIES

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ABSTRACT

The identification and management of hazard areas is a key issue, particularly in the operation of water and wastewater plants where the presence of gases such as methane and Hydrogen Sulphide can generate potentially hazardous areas. Hazardous areas are those defined in the wiring rules as areas of potential explosion risk due to the presence of flammable gas or vapour. This paper presents information relevant to the classification of hazardous areas based on current Australian Standards. The correct application and limitations of current standards are outlined and the use of alternative standards such as NFPA 820 are also discussed.

The relationship of current hazardous area classification and electrical installation requirements in hazardous areas are introduced in the context of minimising the likelihood of explosions. Finally, new directions in standards are introduced including current development work within the IEC, (International Electrotechnical Commission), to include alternative approaches to hazardous area classification based on risk assessment.

KEYWORDS

Risk, Hazard, Explosive, Gas, Wastewater, Electrical

1.0 INTRODUCTION

There are many hazardous areas associated with the water industry, these include physical, biological and environmental. This paper considers those ‘hazardous areas’ as defined in Electrical Wiring Regulations as potentially explosive atmospheres. Within the water industry such potential is most commonly associated with the possible presence of methane or hydrogen sulphide (H_2S) gas. However, there are other materials that may also give rise to potentially explosive conditions.

Within the water industry potentially explosive atmospheres are commonly associated with wastewater treatment plants and underground sewer systems.

Australia has a well established standard (AS/NZS 2430.3), which provides examples and guidance on considering hazardous areas. While a useful guide, this standard is by no means a complete solution. There are many situations where there is a need or justification to depart from the examples provided.

Australia has also recently adopted international standards for hazardous areas (IEC 60079-10). While, in principle, this standard has a similar intent to the previous Australian standard (AS 2430.1), it is an over-ruling standard to AS/NZS 2430.3 and provides for alternatives in approaching classifications.

The future is even more complex and as changes in international standards flow on to Australia more variances in classification will become acceptable. This paper briefly reviews current standards related to classifying hazardous areas in the water industry and looks at possible future changes.

2.0 DISCUSSION

2.1 Current Australian Standards

The 'umbrella' standard for classification of hazardous areas is AS/NZS (IEC) 60079-10. This standard allows for classification from first principles (assessment and calculation), or, classification 'by example'.

AS/NZS 2430.3 'Classification of Hazardous Areas – by Example' is the current Australian standard predominately used for classifying hazardous areas as it is easy to apply. Specific examples for the waste water industry are found in AS/NZS 2430.3.6.

When considering classification by example there are a number of critical points to be aware of. These include:

- The classifications provided are EXAMPLES. They are not mandatory.
- The example classifications cover only selected situations. Other situations may be relevant to hazardous area classification and these need to be identified by the site owner/operator and assessed separately.
- Situations not covered in AS/NZS 2430.3.6 should not be taken as non hazardous.
- The examples are based on typical factors for such items as:
    - Plant conditions (assumed well maintained)
    - Ventilation
    - Construction and operation to recognised standards.
- Variance in any of these items is justification for variance from the example, for both increasing and decreasing classifications.
- The use of other recognised codes such as NFPA (National Fire Protection Association – USA) may be accepted.
- Classifications do not consider issues such as CONSEQUENCE, TOXICITY or oxygen depletion.

Classification by the use of examples can, and occasionally should, be overridden by 'classification by calculation'. This approach is identified in AS/NZS (IEC) 60079-10.

The adoption of the IEC (International Electro-technical Commission) standard is part of a long term policy by Australia for international standardisation. The adoption of IEC standards also means Australia will be bound to accept future developments in the international arena.

2.2 NFPA Standards

In the USA, NFPA 820 is the reference standard for hazardous area classification of waste water treatment facilities. In recent years this standard has come to the attention of some water authorities in Australia and has caused some concern based on the premises applied and the large number of situations identified as potentially hazardous.

NFPA 820 sets criteria for ventilation and makes many assumptions on the likelihood of flammable gas release that could rightfully be challenged and so should be used with caution.

Examples of classification items raised by NFPA 820 that are not identified in AS/NZS 2430.3.6 include common features such as:

- Pipe sewers
- Odour control units
- Sedimentation tanks
- Sumps and wet wells
- Below ground pump stations.

While at first glance it may seem unnecessary to classify these items as hazardous the potential for gas to be present, particularly under different ventilation conditions should not be ignored off hand. One needs also to consider operational reality and how overall risks are managed. If personnel in a sewer system are required to carry methane or H_2S detectors does this not suggest a hazard might exist? If a potential hazard exists then perhaps the area should be classified as a hazardous area.

2.3 Current IEC Standards

Fifteen years ago Australia committed to a policy of working towards the adoption of IEC standards related to hazardous areas.

At this point in time all of the equipment and classification standards have been adopted and progression towards the installation standards is well underway.

The policy of adopting IEC standards is characterised as:

- A very positive and successful decision for Australia and worldwide standardisation
- Requiring continued effort by Australians to influence IEC developments to suit our needs and desires. (To date Australia has been successful well beyond our global weight in influencing IEC developments)
- Committing Australia to adopting new IEC standards ‘warts and all’.

The current IEC standard (IEC 60079-10) has been adopted in Australia embodies principles which are closely aligned to the previous Australian standard, (AS 2430.1), has been readily accepted.

The current standard provides some basic calculations and a few examples for classifications. However, it needs to be clearly understood that:

- The calculations provided are grossly oversimplified and may lead to overly conservative results
- The calculations within the standard provide a basis for assessment of ventilation – not assessment of gas dispersion
- Alternative calculations, or modelling, are accepted
- Examples are not relevant to the wastewater industry.

In short, AS/NZS (IEC) 60079-10 is only of use to the wastewater industry in providing general principles and calculations should use a model relevant to the situation.

2.4 Wastewater Treatment Plants

Irrespective of which standard is referenced there are undeniable hazardous areas associated with wastewater treatment plants, particularly where digesters and gas recovery systems are involved. Having recognised the obvious most engineers immediately refer to AS/NZS 2430.3.6 for the solution.

Recent studies by Maunsell Australia, however, have shown that there may be cause to vary the examples shown in AS/NZS 2430.3.6. This is particularly relevant where gas sources are indoors and can include items such as:

- Gas compressors
- Piping in galleries and basements.

The relationship of the gas source and ventilation is critical. For many plants hazardous areas may not be an issue but cases have been encountered where even with forced ventilation there is a high possibility of gas accumulation.

Figure 1 shows an example of analysis where a gas leak in a ventilated compressor room resulted in a hazardous area despite forced ventilation.

Figure 1: ***Gas Accumulation in a Ventilated Compressor Room***

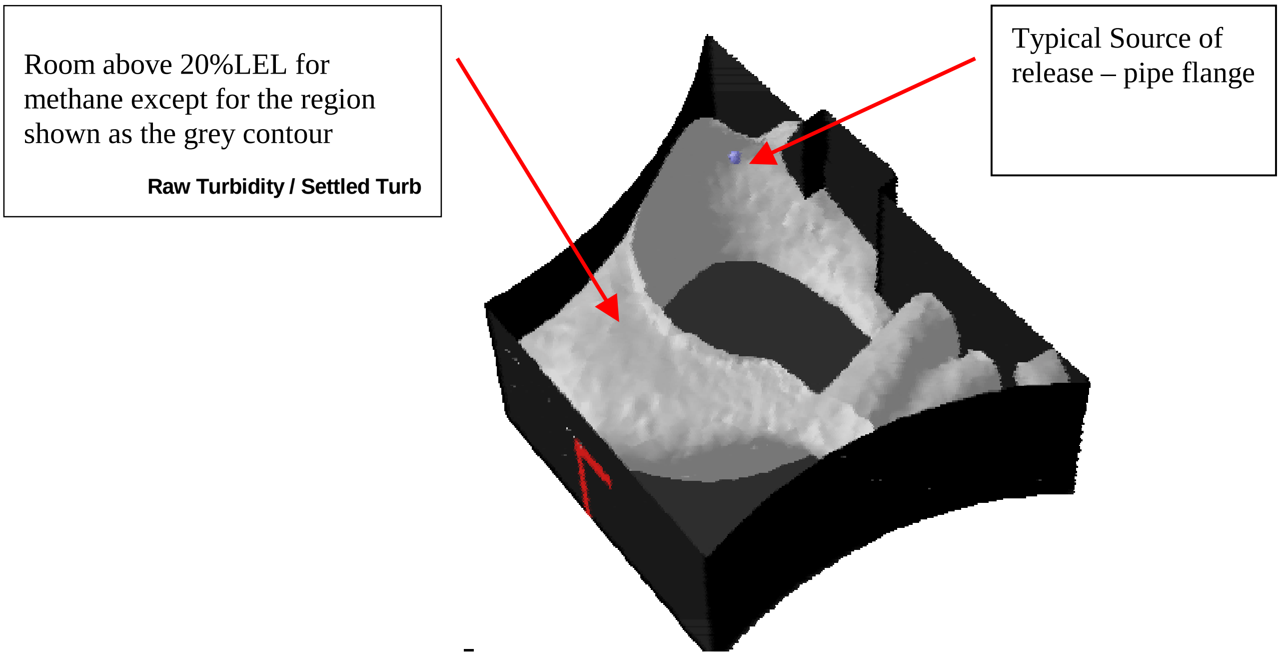
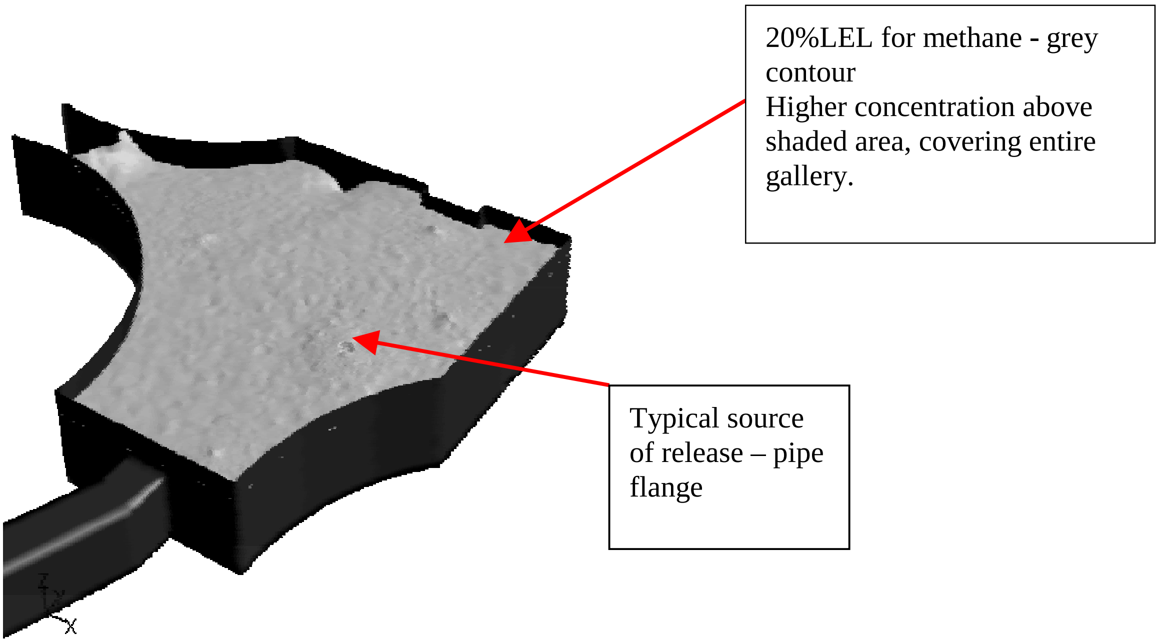


Figure 2 shows an example where a small gas release in a gallery could result in significant layering of gas, within flammable limits, near the ceiling. These figures illustrate the sensitivity of indoor gas releases to ventilation for achieving adequate dispersion.

Figure 2: ***Gas Accumulation in a Pipe Gallery with inadequate ventilation***



2.5 Current Risk Approach

All current standards, worldwide, for the classification of hazardous areas are based on probability factors – what is the likelihood and likely area of a gas or vapour release. The potential for electrical equipment to act as a coincident ignition source is also considered on probability. The likelihood of an explosion is then considered to be as low as reasonably practical:

(i.e.) Likelihood of Explosion = Likelihood of Gas Presence x Likelihood of Ignition Source
= ALARP event (As Low As Reasonably Practicable)

Electrical equipment installed in hazardous areas of higher likelihood is designed to present a lower probability of acting as an ignition source. This approach, current terminology and requirements for electrical equipment are typified in Table 1.

Table 1: ***Current risk approach for hazardous areas***

Likelihood of Gas/ Vapour (above LEL)	Hazardous Area Rating	Likelihood of Ignition Source	Common Protection Basis for Electrical Equipment
Certain	Zone 0	Extremely rare	Intrinsic safety (2 fault tolerant) – Exia
Likely	Zone 1	Rare	Intrinsic safety (1 fault tolerant) - Exib Flameproof - Exd Increased safety – Exc Encapsulated – Exm Pressurised – Exp (with shutdown)
Not likely	Zone 2	Unlikely	Non sparking – Exn Pressurised – Exp (with alarm)
Most unlikely	Non hazardous	Possible	Normal electrical equipment

Under current standards the specifications for electrical equipment operating in each hazardous area 'zone' are tightly specified. However, despite the very strict standards in place for possible ignition by electrical sources standards are generally not applied for even higher probability mechanical ignition sources.

2.6 Future IEC Standards

Development is well underway for the next edition of IEC 60079-10 due in mid 2007.

This next edition of IEC 60079-10 will introduce an option for significant change in the way hazardous area classifications are considered. This change is driven by consideration of 'true risk' as defined in AS 4360 and European council directives. These European council directives are commonly known as the 'ATEX' directives and require compliance with essential health and safety principles for hazardous areas.

'True risk' is not solely based on probability and also considers consequence. Typical risk principles are illustrated in Table 2.

Table 2: ***Typical risk table***

Consequence \ Likelihood	Most Unlikely	Likely	Probable	Certain
Low	Very low	Low	Medium	Medium
Medium	Low	Low	Medium	High
High	Low	Medium	Medium	High
Extreme	Medium	High	High	High

If hazardous area classifications are based on true risk then there are a number options that could be considered. These options include:

- Installing high integrity explosion protected equipment in any zone where there is potential for a fatality from an explosion
- Considering the use of explosion protected equipment in any location where gas may exist – no matter how improbable due to the potential for injury
- Not installing explosion protected equipment in a 'zone 2' area as there is no potential for personal injury. (Or using 'zone 2' equipment in 'zone 1 areas.)
- Using 'zone 2' equipment in 'zone 1' where there are additional safeguards to mitigate an explosion risk, e.g. additional explosion suppression systems

These scenarios represent possibilities that are both more and less stringent than current practices. They highlight the need for operators and asset managers to be aware of the changes and consider what the new standards might hold for them. These changes will also require more consideration by managers in classifying areas in a broader risk assessment context.

In order to select and apply equipment that is appropriate to the risk, new identification systems are proposed for the classifications and the relevant apparatus for use in each classification. This new identification system is illustrated in Table 3.

Table 3: ***Equipment safety and risk relationships***

Risk	Identification	Equipment Safety Criteria
Extreme	Category 1	Protected against initiating explosions even under rare fault conditions
High	Category 2	Protected against initiating explosions with a high level of integrity (or recognised faults)
Medium	Category 3	Protected against initiating explosions
Low	None	Normal equipment

In the next edition of the IEC standards the categorisation of hazardous areas and equipment will be introduced. What will not be defined, however, is consequence. The consequence criteria will need to be considered further and agreement on standard, or uniformly accepted, consequence criteria may be a future issue for industry and government groups.

Finally the IEC is expanding the scope of activities and standards to include other than electrical equipment for hazardous areas. This then opens the way for the specification and categorisation of explosion protection for items such as motors, gearboxes, compressors and other systems. These latest changes will reinforce the need to consider all issues associated with flammable gases in a broad risk management context.

Having already adopted the current IEC standard for the classification of hazardous areas Australia is also committed to adopting the future revision to this standard and is likely to adopt future standards for non electrical equipment.

3.0 CONCLUSIONS

Standards for hazardous areas are changing and broadening. Operators and asset managers should be aware of the following key points:

- Hazardous areas in wastewater facilities are often very sensitive to ventilation issues that are not well defined in relevant standards.
- Broad, hazard identification and risk assessment principles should be followed when dealing with potentially explosive atmospheres not just 'code compliance'.
- Situational examples covered in relevant standards may not be appropriate or the only hazardous areas.
- Calculations provided in standards are rarely relevant. Personnel undertaking assessments need to understand the standards and have access to other tools and information.

Adoption of IEC standards is undoubtedly a positive policy for Australia. The changes proposed for hazardous area classifications are the most significant in 50 years and should be embraced as being consistent with broader risk principles. The changes will, however, take time to resolve and put pressure on industry to come to terms with a common understanding of risk.

4.0 ACKNOWLEDGMENTS

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5.0 REFERENCES

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