Session 10:
Death by Standards

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Introduction

Technology has advanced significantly over the past several decades, and this has resulted in not only better materials of construction but also in tailor made instrumentation and tight process control. As accidents have occurred in the past (Piper Alpha, Bhopal, Flixborough, and other unfortunate events) there is a greater understanding of process systems and materials.

All these advances have led to documenting best industry practice in the form of standards, codes and practices. Legislation has been implemented that often draws upon these standards, however, there application of the standards is not prescriptive. The interpretation and the application of standards is the role of the practicing engineer and s/he should draw upon wisdom in ensuring compliance and most critically safety of the operation.

This paper has very few references as it is an 'applied paper', however it does draw heavily from the usual normative hazardous area classification standards relevant to Australia – AS/NZS 60079.10.1 and API RP 505 specifically. In the context of this paper these standards are those editions that were current as of 2014.

This paper will discuss two classification examples from a recent large LNG project.

Case – Propane bullets installed for operation

Five temporary propane single-skin tanks (bullets) are required to provide fuel for the flare during start-up. Each bullet has a capacity of 25 cubic metres and when depleted is replaced with a fresh bullet. The vapour line from each bullet is connected to a common manifold that then feeds the flare. The bullets are designed to hold boiling propane; the boil-off is generated by heat transferred through the tank walls from the environment.

The challenge was to determine the extent of hazardous area classification consistent with safety requirements and standards.

The ventilation at the location has been determined to be adequate. There are different options – use a generalized method based on Appendix ZB of AS./NZS 60079.10 (similar to API RP 505) or Appendix ZA Classification by example or calculations followed by a level of risk assessment.

It should be borne in mind that the purpose of classification is not to be overly onerous ending up with large classified areas that are not only impractical and have adverse implications on installed equipment.

Applying Annex ZB (or API RP 505) an extent 15 m laterally and 7.5 m vertically and down to grade is recommended; Annex ZA recommends a 9 m lateral extent.

While both classification outcomes presented issues with the installation, further study was considered.

Analysis

Process with source of release method

The key question was revisited – what is being classified? Is it a storage tank (closest example in Annex ZA) or is it a process vessel? The vessels are part of a process similar to any high pressure vessel. The question then is when considered a process vessel (similar to any high pressure equipment such as a filter in a gas line or column) the classification will be less onerous when considering release points around flanges for example. This approach may yield a small zone extent around the vessel, but without detailed calculations or evidence there may still be an element of risk as the vessel still holds a significant quantity of heavier than air gas.

The next step was to consider more evidence and perform an assessment and calculation if required.

Detailed Assessment

As there is a risk associated with large quantities of propane storage, it was felt that some more research was needed to ensure that the classification was sensible. A recent publication by Abid and Khan (2013) has published the leakage rate from gasketed flange joints. Their data is based on experimental research. The application of data from their paper indicates that it is not possible to have a total leakage rate from all the flanges associated with propane bullets assembly of more than 30,000 mg/s. In reality the actual release from each flange (poorly tightened) is about 0.2 mg/s. Using such a low flow rate although physically determined still leaves a lot of questions unanswered regarding safety. Therefore a notional zone extent of 3 m was considered from each flange and then an iterative calculation performed to determine the maximum possible release. Applying the calculation methodology in Appendix B of AS/NZS 60079.10, and based on the weather conditions at the location, the total volume (V_z) of the potential zone 2 is 57 m^3. This corresponds to a radius of 2.9 m corresponding to a maximum possible release of 30,000 mg/s.

Applying a reasonable level of margin the radius is rounded up to 3 m and the zone reckoned as 3 m around each propane process / storage vessel. What is to be stressed here is that laws of physics have been coupled with practical experience of the classifier. A zone extent of 3 m in all directions from the boundary of each tank is still sufficiently conservative, consistent with laws of physics and subscribes to safe practice.

Discussion

It should be clear that the objective of the exercise was not to just reduce the zone extent, but to ensure that the zone extent is consistent with the laws of physics and incorporates the outcomes of a risk assessment.

It is often tempting to reference Appendix ZA, choose a suitable example and apply the classification as stated. More often than not this approach is sensible and provides a safe estimate, however, these examples should be applied with care.

In this example three extents of 15 m (generalized method), 9 m (classification by example), and 3 m (classification by assessment) were possible. The final classification of 3 m was based on a detailed assessment of ventilation which was found to be good (average air velocities of 5.3 m/s) and availability medium; an assessment of application of the vessels – process versus just storage; and a realistic assessment of leak rates from flanges based on real information (published peer-reviewed literature).

Case - MEG storage

In another example a classification engineer had used the generalized method to classify mono ethylene glycol (MEG) and condensate storage tanks. The impact of this classification was that a field equipment room (FER) was now well within the zone extent created by these tanks, and the consequence was the need for equipment suitable for the zone. The room was already shipped and changes at this late stage would amount to millions of dollars.

As a first step the contents of each tank were examined from a process perspective. The upstream process steps were reviewed and understood thereby providing a better understanding of the contents of the tanks. While the MEG tank internally is at a temperature above the flash point of MEG, the environment in which the tank is located can never reach the flash point of MEG. MEG is a benign liquid at temperature below 124^{o}C and is therefore considered non-hazardous below its flash point. Furthermore this is a rich MEG storage tank and rich MEG implies dilution with water.

Therefore all flanges around the vessel should have a negligible extent of zone 2 around them. The generalized method was applied incorrectly resulting in a lateral zone 2 extent of 15 m and bringing the FER within the zone.

Discussion

In this example the application of the generalized method was not incorrect, but was based on a single piece of information – ‘MEG at a temperature above its flash point’. Based on this information the zone extents are correct, but the classification engineer did not have an appreciation of the process and blindly applied the Standard.

Concluding Remarks

In the preceding two examples the point has been made that while adherence to standards is critical and in some cases mandatory, it is important to apply them with some wisdom.

The classification engineer should not lose sight of the purpose of classification which is to determine realistic hazardous area zone extents that will ensure safe operation of the facility. The classification engineer should use all the tools and information available to him / her in arriving at a meaningful classification.

Unrealistic classification can lead to potential safety, operational and cost issues.

References

AS/NZS 60079.10.1:2009 Explosive Atmospheres: Classification of areas - Explosive gas atmospheres (IEC 60079-10-1, Ed.1.0(2008) MOD)

Recommended Practice for Classification of Locations for Electrical Installation at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2 (2002)

Abid, M. and Khan, K. A, Leakage rate analysis through gasketed flange joints, Proceedings of the International Conference on Energy and Sustainability, NED University of Engineering and Technology, Karachi, Pakistan 2013