Session 8:

Risk Based Prioritisation of Ex Equipment Non-Compliances

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INTRODUCTION

In most facilities, electrical equipment in hazardous areas must be installed in accordance with AS/NZS60079.14. Due to decay, damage, incorrect original installation, or maintenance, electrical installations in hazardous area may not be fully compliant with the installation standard.

Many OpCos spend hundreds of thousands of dollars conducting periodic Ex inspection campaigns, in accordance with AS/NZS60079.17. It is usually not possible to rectify all of these Ex non-compliances immediately. This is especially true when there are many Ex non-compliances. The non-compliances are usually prioritised for rectification. However, in most cases there is no structured and justifiable basis for the prioritisation applied. This paper will discuss a qualitative risk based approach to prioritisation to ensure that the Ex non-compliances creating the highest risk are addressed first. The methodology achieves a balance between being simple to apply vs. considering all of the factors that contribute to the risk.

In the context of this paper, risk is the probability that the Ex non-compliance will create an uncontrolled explosion, multiplied by the consequence of that explosion.

> NOTE: An uncontrolled explosion is any explosion that is not inside a fully functioning Ex d enclosure.

RISK

RISK = Probability of Uncontrolled Explosion Potential x Consequence

The consequence of an uncontrolled explosion can be measured by the impact it would have upon the asset owner. This could be measured in terms of loss of human life, loss of plant, loss of production, impact upon corporate image, etc. etc.

The consequences of an explosion are probably less serve for a remote well-head compared to an offshore platform with many people onboard. However, for most facilities it is not necessary, nor practical, to assign different values to the consequence of an explosion for different parts of the facility. Therefore, if the consequence is consistent across the facility, the risk created by the Ex non-compliance is proportional **solely** to the probability that the Ex non-compliance will create an uncontrolled explosion. Hence, to prioritise the Ex non-compliances, the probability that they will create an uncontrolled explosion has to be determined.

This paper will suggest possible methodology, using a basic qualitative risk assessment, based solely upon the probability of an uncontrolled explosion being created by an Ex non-compliance.

PROBABILITY OF UNCONTROLLED EXPLOSION

The probability of an uncontrolled explosion is determined by the probability that a flammable atmosphere will exist and the probability that the Ex non-compliance will generate sufficient energy to ignite the flammable atmosphere. The probability of presence of a flammable atmosphere can be inferred from the hazardous area classification zone (e.g. Zone 2 will have a low probability of presence compared to Zone 1). The probability that an Ex non-compliance will create an ignition source can be ranked based upon sound engineering judgment.

PROBABILITY OF IGNITION SOURCE

The 'probability of ignition source' due to a specific Ex non-compliance is an engineering judgement. To ensure consistent prioritisation, it is important that a detailed set of guidelines exist which clearly list the assigned ''probability of ignition source' for specific Ex non-compliances. It is suggested that the Ex non-compliances be assigned a 'high', 'medium', or 'low' 'probability of ignition source'

Some specific non-compliances (e.g. loose terminals) can have a different 'probability of ignition source' depending upon the technique. Therefore, the guidelines should have a general section for all techniques, and then specific sections for each technique. This will enable the Ex non-compliance to be more accurately assigned a 'probability of ignition source'.

For Ex d equipment, the risk associated with Ex non-compliances that could compromise the ability of the enclosure to contain an explosion is related to the probability that the enclosure will have an ignition source inside. Therefore, if the Ex d enclosure only houses feed through terminals, or other normally non-sparking devices, the risk is lower than if the Ex d enclosure has normally sparking devices inside. Therefore, it is suggested that to avoid overstating the risk, the guidelines should assign different ''probability of ignition source' ratings to Ex non-compliances that could compromise the ability of the enclosure to contain an explosion depending upon the contents of the Ex d enclosure.

The key factor in making this type of methodology work effectively is to ensure that the guidelines contain sufficient examples (we use about 20+ per technique). An Ex inspection checklist is a good starting point for creating the guidelines as a good checklist will contain many of the items that need to be in the guidelines. However, some items from the checklist might need to be broken down further for use in the guidelines.

Another key factor is that the Ex non-compliances must be spread across the 'probability of ignition source' ratings (high, medium, low). If there is not a good spread, and most of the Ex non-compliances are assigned the same 'probability of ignition source' (e.g. high), this will result in most of the non-compliances having the same priority, which defeats the purpose of the methodology.

When assigning the 'probability of ignition source' for the Ex non-compliances, the probability must not be overstated. There is always the temptation to be overly conservative. However, as the non-conformance are analysed and categorized a 'picture' develops and most non-conformances can then be easily assigned a category based upon the categories of the other non-conformances. Sometimes when trying to assign a category it becomes apparent that the category depends upon another factor. In these instances the non-conformance has to be changed into two non-conformances. For example, in a gaseous hazardous area environment an IP related non-conformance might have a very low ignition potential in an item of IS equipment. However, if the item was an IS junction box with multiple loops that could be shorted with water ingress, then the ignition potential is higher.

Some Ex non-compliances have such a low probability of creating an ignition source that they do not have to be assigned a 'probability of ignition source'. They can be catagorised as 'Priority 4' regardless of the Zone (e.g. poor quality terminations in Ex d enclosure).

For many non-compliances, the ignition source potential is created due to the reduction in IP rating. However, an ignition source can only occur if this reduction in IP rating could credibly result in water or dust ingress that could create an ignition source. Therefore, a non-compliance of an IP washer missing from a gland might be a low 'probability of ignition source' if the entry is threaded (as the thread itself will provide a reasonable IP rating). Similarly the location of the equipment (indoors, outdoor, deluge area) and location of the missing washer (top, side, bottom entry) could affect the potential for water/dust ingress and thus the 'potential for ignition source'. These factors, and other similar factors, need to be considered when creating the guidelines to ensure the correct 'probability of ignition source' is assigned to the non-compliance.

PRIORITISATION

To determine the priority for remedial work for an Ex non-compliance the zone of the installation should be determined from the hazardous area classification documentation, and the Ex non-compliance's 'probability of ignition' (low, medium or high) is determined based upon the guidelines developed.

The priority assigned to the remedial work is determined from Table 1.

TABLE 1 : PRIORITISATION ASSIGNMENT

Probability of Ignition	**HAZARDOUS AREA ZONE**		
	Zone 2	**Zone 1**	**Zone 0**
LOW	4	3	1 (Note 1)
MEDIUM	3	2	1
HIGH	2	1	1

NOTE

1. Although low ignition potential non-compliances in Zone 0 could possibly have been assigned a lower priority than shown in Table 1, to allow for misapplication of the 'probability of ignition' guidelines, all the non-compliances in Zone 0 have been assigned priority 1.

If an item has multiple Ex non-compliances, each non-compliance should be assessed individually. The presence of multiple non-compliances on one item of equipment does not affect the priority (e.g. if one item of equipment has six priority 4 non-compliances, and another item of equipment has one priority 2 non-compliance, the equipment with the priority 2 non-compliance should be rectified first). However, it might be efficient to rectify all non-compliances on an item of equipment at the same time (e.g. if an item has a priority 2 non-compliance and two priority 4 non-compliances, it might be efficient to rectify the two priority 4 non-compliances when the priority 2 one is being rectified).

OTHER FACTORS THAT COULD BE INCLUDED WHEN PRIORITSING

Table 1 assigns a priority based upon the probability of presence of a flammable atmosphere (determined by the zone) and the probability of an ignition source (determined by the guidelines' assessment of the non-compliance). However, many Ex non-compliances result in a potential ignition source **inside** the equipment. If a flammable atmosphere is present external to the equipment, the flammable atmosphere has to enter the equipment and reach the LEL inside the equipment before ignition of the atmosphere can occur. Thus electrical equipment with a good IP rating has an inherent layer protection due to the enclosure acting as a barrier between the ignition source inside the equipment, and the external flammable atmosphere. An Ex non-compliance remedial prioritisation system could include 'probability of gas ingress' into the decision making process. However, this would increase the decision making complexity because:

- Some Ex non-compliances can result in potential ignition sources external to the enclosure.
- A flammable atmosphere could enter an enclosure when the cover is open (e.g. during maintenance) and then remain therein.
- For some equipment (e.g. pressure switches), failure of the process containment system can introduce flammable fluid directly into the enclosure.
- It would be difficult to determine the impact of some Ex non-compliances (e.g. damaged door seal) upon the ability of the enclosure to prevent external atmosphere ingress.

Although gas ingress into the equipment could be factored into the prioritisation methodology, the prioritisation methodology suggested in this paper has claimed no credit for the enclosure restricting gas ingress to the equipment. I.e it is conservatively assumed that a flammable atmosphere is always present inside the equipment when there is a flammable atmosphere outside the equipment (unless the technique specifically excludes the flammable atmosphere e.g. Ex p or Ex nR).

Another factor that could be included is current. Intuitively, high current electrical equipment will probably have a higher ignition potential than instrumentation equipment with a similar non- compliance due to the higher energy in an electrical spark. However, for simplicity, this has not been considered in the prioritisation methodology in this paper.

CONCLUSIONS

To effectively manage Ex non-compliance remediation, a system of prioritisation is required. A simple risk based methodology can be developed based upon the zone where the equipment is located, and the potential that the non-compliance can create an ignition source.