Ex Inspections—Potential Pitfalls

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Introduction

Many, if not most, Ex inspection campaigns are grossly inefficient, and their effectiveness is often questionable. This presentation will discuss the four main reasons why Ex inspection campaigns fail to meet the clients' expectations. It also offers recommendations to improve the quality and efficiency of Ex inspections.

This paper will focus on the problems which are directly related to the inspection process. It has been written from the perspective of the Ex inspection team who usually have no control over the design and installation process. It is acknowledged that the competency of the design and installation personnel will affect the quality of the installation that is to be inspected.

The failure of Ex inspection campaigns can be attributed to four main areas:

- Poor planning of the Ex inspection activities
- Lack of competence of the Ex inspectors
- Lack of clarity of the inspectors' roles
- Lack of clarity of the inspection scope

Whilst conducting Ex inspections efficiently is not difficult, it is the author's experience that the majority of Ex inspection campaigns are often doomed before they start, usually for **all** of the reasons listed above.

Although the incorrect selection of the periodic inspection frequency will also ultimately affect the overall efficiency of Ex inspections, the methodologies for determining how often periodic inspection are to be conducted are outside the scope of this presentation.

Ex Inspection Requirements

Ex inspections are driven by the AS/NZS2381 series of standards. These standards require that Ex equipment located in a hazardous area be inspected prior to use (initial inspection) to ensure it is safe to energise in a hazardous area and that the Ex integrity has not been compromised, and also on a regular basis (periodic inspections) to ensure that the equipment has not been damaged, and that its Ex properties have not been compromised by corrosion, decay, wear and tear, etc.

There are three 'grades' of Ex inspection applicable to certified electrical equipment installations: detailed; close; and visual. The 'grade' of inspection relates to the **amount of detail** involved in the inspection.

A visual inspection identifies those defects that are apparent to the eye without access to the equipment (eg. missing bolts, and unplugged cable entries). A typical visual inspection would be a light on a pole, which would need a ladder or scaffold to access it.

A close inspection covers all the aspects covered by a visual inspection, and in addition, identifies those defects that are only apparent when the equipment can be accessed (eg. loose bolts or glands, IP washers not fitted, etc.) In addition, certification plate details, including checks for conditions of use, can be actioned during a close inspection. Ex equipment should be installed where it is accessible for maintenance and inspection, therefore, the majority of Ex-equipment can easily be inspected at a close grade.

A detailed inspection is the most thorough inspection possible. It covers all the aspects covered by a close inspection, and in addition, identifies those defects that are only apparent when the enclosure is opened (eg. loose terminations). All initial inspections must be at this grade.

Pitfalls:

I. Lack of Planning

Many project managers and high-level management in the end user's and installation contractor's company view initial Ex inspections as 'an end of project evil' that will delay start-up and consume project dollars. These inspections often delay the ship, module or platform leaving the fabrication yard thereby increasing yard costs, and they can delay the commencement of plant start-up, etc. As a result, it appears that many project managers hope that no-one remembers that initial Ex inspections are required. Even if a project agrees that Ex inspections will be actioned before start up, they are seen as a 'lumped' activity at the end of the project.

When the Ex inspection team appears on site to start the initial Ex inspections they often are faced with the following problems:

- They cannot access the equipment due to: scaffold being removed; equipment being preserved for transport ; equipment being already live for pre-commissioning; etc.
- They cannot easily access hazardous area information such as classification drawings, certificates of conformity, location drawings, schematics, entity calculations etc.

The solutions to avoid pitfall 1 are:

1. The Ex inspection activity for each item of electrical equipment must appear as a discrete activity in the project Gantt chart. In addition, its interaction with all other activities such as pre-commissioning, removal of scaffold, removal of isolations, etc. must be detailed in the Gantt chart. Resources must be allocated to the Ex inspection activities in the Gantt chart.
2. Information that will be required for the Ex inspection needs to be collected and collated prior to inspections commencing. It is preferable that the person who will be co-ordinating the Ex inspections does this well in advance of the start of the Ex inspections so that any potential problems are identified prior to the Ex inspections commencing.

NOTE: Planning for Ex-inspections starts during the engineering and design phase of the Project, to ensure all certificates of conformity have been obtained and reviewed, all entity calculations completed prior to commencing construction, etc.

II. Lack of Quality Inspectors

It seems with the current Australian resource boom that every electrician wants to be an Ex inspector, and every electrical contracting company wants its electricians to be Ex inspectors. Very few people seem to realise the depth of knowledge required to be a competent Ex inspector. Most electrical contracting companies think they just need to send their electricians on an 5 day course after which they are considered to be competent to inspect (i.e. the sausage factory approach).

All Ex-inspectors must be competent. However, having a Statement of Attainment stating that the owner is competent to UTENES410A (Detailed Ex inspections) does not mean that he is a competent Ex inspector. It is no different to an engineer with a degree, or an electrician with an electrical licence - there are some excellent engineers and electricians, and there are some who are woefully incompetent. Ex inspectors are no different.

Even if the Ex inspector was truly competent when his Statement of Attainment was issued, he might not be currently competent, especially if he has not being utilising the skills and knowledge he had when he was deemed competent, particularly with the rapid changes occurring in the Standards.

Some Ex inspectors are so thorough that if anything is wrong with the installation, 99.99% of the time they will find it. However, they only conduct one or two inspections per day. They are very inefficient. Others are both slow and not very thorough. A good Ex inspector will be able to inspect the equipment at a reasonable pace, and he will also find the vast majority of non-conformances. A good Ex inspector has found the pragmatic balance between finding what is wrong with the installation, and doing it quickly.

The solutions to avoid pitfall 2 are:

1. Interview all Ex inspectors before you hire them. Treat their Statement of Attainment as an admission ticket only to the interview. At the interview cover technical matters. Spend 20 minutes asking structured questions about how the Ex techniques work and installation requirements. Don't ask the basic questions. Everyone who has worked in a hazardous area can tell you how a flameproof box works. For Ex d, ask questions like: "What am I allowed to place inside an Ex d box?" and, "What is pressure piling?" and, "How might a IIC Ex d enclosure be physically different to a IIA Ex d enclosure?". For intrinsic safety ask questions like: "Is a loop IS if I place an Ex d transmitter on a barrier, and why?" and, "Explain to me the entity concept". Use similar 'deeper' level questions for all techniques and installation rules. It's these deeper questions that show you who knows their Ex theory.
2. Follow up their references. Find out from past clients how quickly and accurately they have inspected in the past.
3. Give them a small portable 'mock-up' installation to inspect at the interview. A small Ex d-box with a couple of glands and short stubs of cable is ideal. Watch them inspect it. A good Ex inspector will look at the installation holistically and will have already identified most of the non-conformances. He will then use the inspection checklist to record his findings and see if he has missed any checks. A poor Ex inspector will check each item on the checklist line by line, in order. This significantly increases the inspection time required, and if its not on the checklist, the inspector will miss it.

Although these solutions take time to action, the payback can be nothing short of phenomenal. A good Ex inspector can be not only many times quicker than an 'also ran', but he will also find more non-conformances.

III Lack of Clarity of Inspectors' Role

Non-Ex issues

The inspection requirements in the AS/NZS2381 series cover Ex issues only. 'Other' electrical inspections will be required to ensure that the equipment is electrically safe to energise, and meets project requirements. Although these 'other' inspections are outside the scope of the Ex inspections, the Ex inspector might notice non-Ex issues whilst he is actioning the Ex inspection. For example, he might notice a missing IP washer on a gland entering an Ex d enclosure. Should he report this? The IP washer is not fundamental to Ex integrity for Ex d, but its absence may affect the operability of the plant if water ingress causes the equipment to short-circuit and as a result the plant is tripped. The inspector is in a no-win situation. If he reports these 'issues' they may be construed as Ex issues so they have to be fixed. Conversely, if he doesn't report them and the plant trips when there is a heavy rain-storm he is blamed because he never reported the missing IP washer on the Ex d enclosure.

The solution to avoid this pitfall is:

> Record the non-Ex non-conformances on the inspection checklist but state 'Not Ex issue' next to the non-conformity. This 'each way bet' makes it clear that the issue is not an Ex inspection issue, but lets the client know there is a non-Ex issue that he may want to address.

Prioritising Non-conformances

A universally contentious issue for all inspectors (including non-electrical inspections) is should the inspector give all non-conformances a priority depending upon its 'seriousness'. Many Ex inspection checklists have a priority column in which the inspector assigns a priority A, B or C depending upon the 'seriousness' of the non-conformance. Hopefully the following examples will identify the difficulty in assigning these priorities. For the following non-conformances, assign a priority as follows: A (high, do not re-energise until rectified), B (medium, rectify as soon as possible (even if this will affect plant operations), but can be livened up in the interim), C (low, rectify at next available opportunity that does not affect operations, but can be liven up in the interim).

Example 1: An Ex e enclosure has a missing IP washer on a gland. Priority ___

Example 2: An Ex d enclosure has a very deep gouge all the way across its flamepath. (NB. It is obvious the flameproof box will not be able to safely contain an internal explosion). Priority ___

Having assigned a priority, how might the following variables change your answer?

Example 1: An Ex e enclosure has a missing IP washer on a gland.

- Is the gland on the top or bottom of the box?

- Is the box indoors or outdoors?
- Is the box in a deluge area or hose down area?
- Is the gland entry a clearance hole or a threaded hole?
- Is the box in Zone 2 or Zone 1?

Example 2: An Ex d-enclosure has a very deep gouge all the way across its flamepath.

- Does the box have only terminals inside, or normally sparking devices too?
- Is the box in Zone 2 or Zone 1?

For example 1, if the gland is bottom entry via a threaded entry in an indoors non-deluge/hose-down location, and the zone is Zone 2, the probability of gas being inside the enclosure whilst water enters via the gland to enclosure joint is minimal. However, if it was Zone 1, top entry with a clearance hole and the area was regularly deluged we have a completely different probability of an explosion occurring due to the missing IP washer.

Similarly, a destroyed flamepath on an Ex d enclosure with only terminals inside located at the fringe of a Zone 2 area (nearly in a safe area) is possibly a million times less likely to transmit an explosion than a similar box with regularly sparking contact inside, in the middle of Zone 1.

The above identifies that a universal priority cannot be assigned to a non-conformance on a particular item on a checklist. For example, a damaged flamepath is not always an A priority.

To compound this situation, there are other factors that need to be considered apart from the probability of the non-conformance causing an ignition. These factors relate to the consequence of ignition. For example, if the facility is an unmanned wellhead, or is an unmanned facility close to the end of its useful life, a risk assessment might place a completely different priority on a non-conformance compared to a similar non-conformance on a heavily-manned offshore platform worth billions of dollars.

It could therefore be argued that the Ex inspector's role is **only** to find the non-conformities. The priorities should be assigned by others. This approach works very well for initial inspections when everything is isolated and there is usually time to rectify the non-conformities prior to start up. However, when inspecting an existing equipment, the inspector invariably has to decide what to do, when he see non-conformances. For example, a missing Ex d-blanking element in a live Ex d enclosure will seriously impact the integrity of the enclosure so most inspectors would fix the non-conformance before continuing with the inspection.

The solution to avoid this pitfall is not easy. The best solution is:

> Do **not** have a column for recording priorities on the Ex inspection checklist. Priorities should be assigned post inspection by people in a better position that the inspector to understand the risk created by the non-conformity. However, when inspecting existing installations, each inspector will invariably make 'de-facto' priority calls based upon his perception of the seriousness of the non-conformity.

IV Lack of Clarity of Inspection Scope

Lack of planning (refer pitfall 1) is never more evident than when the potential client calls and clearly has no idea what needs to be done. The following are two real examples.

Example 1: The client called and said he had about 100 items that need to be **visually** inspected in an Ex installation. It would be reasonable to assume that is would be a very small job as all the inspections were visual. However, we knew that this was a new installation so we confirmed that the inspections would have to be detailed rather than visual. When we enquired if the equipment was still electrically isolated so we could conduct the internal part of the inspections we were told that they should be able to work around this, but the plant was actually in use. Apart from the problems of equipment access (many items were high bay lights), and electrical isolation problems, we then identified that there were closer to 700 items. So within 30 minutes we had moved from 100 visual inspections to 700 detailed with significant access issues.

Example 2: The client called and said he had about 1000 items that need to be initially inspected on a large Ex installation, and could we lead a team of 4 inspectors for a few months to action the inspections. We thought that 1000 seemed low for a facility of this size so we queried this and were told that it may be closer to 3000 items. We arrived at site on day 1 and spent the whole day going through the project data-base and deleting all the non-electrical items, and the electrical items in a safe area. We were left with 16,000 hazardous area items to inspect.

It is blatantly obvious in cases like those above that the client has no idea whatsoever as to what the Ex inspection scope is. It doesn't need a rocket scientist to work out that the whole of the inspection campaign will be a nightmare.

Even when the number of items to be inspected, and the grade of inspection are known, and the isolations and access issues are addressed, the exact scope of the inspection still needs to be determined. Although most Ex inspectors will use a comprehensive checklist to ensure that all the relevant checks are made, and to record their findings, the interpretation of the required checks is another area for inconsistency between inspectors, and disagreement between the client and the inspection company.

The specific requirements for Ex inspections are contained in the AS/NZS2381 series of standards. Most Ex inspectors know that there are some checks therein that are not practical, and other logical checks are not included in the standards. Therefore most people use their own Ex inspection checklist which whilst based heavily upon the content of the AS/NZS2381 series, are not identical.

Most checklist items are a few words. For example, "There are no unauthorised modifications", or "Cables are not damaged." However, even these simple checks are fraught with different interpretations. Some examples follow:

- "There are no unauthorised modifications" could be interpreted to mean that the inspector is 100% certain that an Ex d box has not been modified since supply. To make this assessment he will need the details of exactly what was supplied, including the number and size and location of all cable entries, bolt materials, were washers fitted to the bolts, etc. This information is not easy to obtain, and this single check could take hours or days to assess. An alternative interpretation of this check is to ensure that there are no obvious stand-out modifications. This assessment can be made in seconds. It would involve the following: Do all the bolts look the same? Are there any cable entries at unusual locations or angles? Does the box as installed look credible? The $64,000 question is "Which approach is correct?"
- "Cables are not damaged." When checking for cable damage, do we check locally at the equipment, or do we walk the whole cable route?

- ‘Terminals are tight.” When checking that terminations are tight, in a large marshalling box do we check every terminal, or just a sample?

A checklist might contain 40 or more relevant checks. We have shown above that these items are open to interpretation. Depending upon how the check is interpreted, the time to conduct the Ex inspection could vary dramatically.

Similarly, some checks on the checklist involve verification that tests have been conducted (eg. Are overloads set correctly, Is cable insulation OK). On a large project there probably is already a system in place to capture and ensure that all tests are conducted. Thus, there is no benefit in the inspector retrieving these test results simply so he can tick a box on the Ex inspection checklist. It is far more efficient to remove these items from the Ex inspection scope and capture them elsewhere.

The solutions to avoid pitfall 4 are:

1. The inspection co-ordinator must liase with the client and determine ‘exactly’ what each check on the checklist means, and equally important, what it does not mean. Effectively they expand and clarify the scope of the short phrases on the checklist. Next they determine what checks can be deleted and captured elsewhere.
2. Document the decisions made above by amending the checklist and producing a users guide explaining what each check on the checklist means on this campaign.
3. Brief the Ex inspectors on the decisions made above and give them a copy of the checklist users guide for the campaign.

Conclusion

Ex inspections usually fail to deliver the required results, or they deliver them inefficiently, due to lack of planning and preparation. Pre-investing time and resources to clarify the exact inspection scope, planning the inspection activities with regards to other activities, and sourcing good quality inspectors can pay back the financial investment many times over. In addition, the Ex inspection campaign will run smoother, and won’t be as big an ‘end of project evil’ as it is usually perceived to be.