

Learning from major incidents related to process safety audits

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Process safety management auditing is a process of systematic examination to assess the extent of conformance with defined standards and recognised good practice and thereby identify opportunities for improvement. What is similar in every organisation is the need to understand what processes or systems are important to manage process safety and then monitor and verify them. Understanding the health of an organisation's process safety management system, requires a comprehensive assessment of the content and implementation of its programs. A combination of testing, inspection, lagging and leading metrics and audit are helpful tools to achieve that. Regularly checking the system to receive valuable feedback makes it possible for plant managers to set up a robust system and implement all necessary measures to prevent major incidents.

This paper shows and discusses two major incidents, focusing on two different aspects; the first one explores when audit findings got ignored or overlooked and the second incident shows when audits failed to address problems in the system. The paper suggests practical recommendations to avoid future recurrence of such events. These recommendations are structured based on the different, major roles within an industrial site, from management level to operator level, through process safety engineers, supervisors and auditors. Having those suggestions separated based on the different roles supports easier recognition and implementation of the learning points.

Keywords: process safety audits, major incidents, lessons learned

Introduction

Process safety management auditing is a process of systematic examination to assess the extent of conformance with defined standards and recognised good practice and thereby identify opportunities for improvement. It should also test whether the systems and safety barriers are effective at managing risk. What is similar in every organisation is the need to understand what processes or systems are important to manage process safety and then monitor and verify them. Understanding the health of an organisation's process safety management system, requires a comprehensive assessment of the content and implementation of its programs. A combination of testing, inspection, lagging and leading metrics and audit are helpful tools to achieve that. Regularly checking the system to receive valuable feedback makes it possible for plant managers to set up a robust system and implement all necessary measures to prevent major incidents.

This paper shows and discusses two major incidents, focusing on two different aspects; the first one explores when audit findings got ignored or overlooked and the second incident shows when audits failed to address problems in the system.

The first catastrophic event occurred in an oil refinery. Years prior to the tragic explosion there were many occasions where internal studies revealed serious concerns about the potential for a major incident due to the large number of hydrocarbon releases. In this case the organisation had both internal and external or third-party audits which pointed out critical issues ongoing in the operations and those findings were communicated to the management; yet no follow-up actions were taken. In hindsight, the findings of those studies could have been considered as early warning signs to prevent the incident from occurring.

The second case occurred in a chemical manufacturing plant. That event demonstrates when audits completed by the organisation internally and by an external team and both failed to recognise the flaws in hazard identification and other potential failures in the plant. Not being able to pick up on those matters then led to the major incident.

In both cases the author describes how each incident occurred and presents key findings that would assist in better understanding the learning points in process safety auditing.

Following the analysis of the studies from these two different angles, the paper suggests practical recommendations to avoid future recurrence of such events. These recommendations are structured based on the different, major roles within an industrial site, from management level to operator level, through process safety engineers, supervisors and auditors. Having those suggestions separated based on the different roles supports easier recognition and implementation of the learning points.

1. Case studies

The following two case studies provide some further information about what can go wrong when audit findings are not followed up or the audit does not reveal important issues and those remain unnoticed. The first case is the explosion at the Texas refinery a high visibility event that provides various angles to learn; and one of the learning points, which might have contributed to the tragic explosion is related to the fact that audit findings were not followed up. The second case, on the other hand, will highlight what can happen when the audit fails to recognise underlying problems in the facility which then leads to a loss of containment event.

1.1 Case 1 – Oil refinery explosion

On March 23, 2005, a series of explosions occurred at an oil refinery during the restarting of a hydrocarbon isomerisation unit. During the start-up, operations personnel pumped flammable liquid hydrocarbons into the raffinate splitter tower for over three hours without any liquid being removed (as opposed to what was in the written procedures). Critical alarms and control instrumentation provided false indications that failed to alert the operators of the high liquid level in the tower. Consequently,

unknown to the operations crew, the tower was overfilled and liquid overflowed into the overhead pipe at the top of the tower. As a result, the blowdown drum and stack was overfilled with flammable liquid, which led to a geyser-like release out of the stack. The released liquid evaporated as it fell to the ground and formed a flammable vapour cloud that found an ignition source and exploded. Fifteen people were killed and 180 others were injured with major damage caused to the unit and the adjacent plant and equipment.

1.1.1 Key findings

Years prior to the tragic explosion there were many occasions where internal studies revealed serious concerns about the potential for a major incident due to the large number of hydrocarbon releases; over 80 in the 2000-2001 period and the findings were communicated to the company management. Further audits between 2002 and 2004 and studies highlighted “inadequate level of hazard awareness and understanding of process safety and lack of early warning system for process safety exposures”. Between 1994-2004 eight serious blowdown drum incidents occurred and these events were not effectively reported or investigated. External audits, one in 2003 and another in 2004 indicated the insufficient incident investigation system in place. In 2003, the unit HAZOP revalidation missed addressing previous incidents with catastrophic potential. Other findings from an external ISO14001 audit revealed that “by not robustly addressing issues identified through inspections and audits, and ensuring that a preventative element is included in the corrective action, management is not taking advantage of the opportunity to prevent undesirable outcomes”. An internal report a few months prior to the explosion pointed out that safety was not a priority and that may result in casualties in the foreseeable future, within 12-18 months’ time.

1.2 Case 2 – Oil refinery fire

On November 15, 2014, approximately 11 tonnes of highly toxic methyl mercaptan was released from an insecticide production unit of a chemical manufacturing facility. The release took the lives of three operators and a shift supervisor inside the building as a result of the combination of asphyxia and acute exposure (by inhalation) to methyl mercaptan. For several days leading up to the leak, operations personnel attempted to clear blocked piping outside of the manufacturing building. Two workers went to drain liquid from piping inside the building as a routine operation believing it was an unrelated pressure problem. Instead, it was related to the clearing activities. Liquid methyl mercaptan drained from the piping and filled the manufacturing building with toxic vapour.

1.2.1 Key findings – audits missed issues

An external audit in 2007 identified the existence of the methyl mercaptan detection system but did not evaluate whether this system could effectively protect workers by warning them of potentially toxic environments. It found the detection system to be in conformance simply because it existed. During the incident, methyl mercaptan detectors were alarming; however, the system did not signify an early release of methyl mercaptan, because the alarms were set above the ceiling limit set by standard and they were not communicated to personnel. An effective audit would identify such gaps in the system but in this case, it did not pick up the problem. One third-party audit and six self-audits were completed between 2007 and the date of the incident. None of these audits identified or effectively corrected the many serious and long-standing process safety deficiencies at the site. The investigation revealed, that the Responsible Care external auditors have short amount of time to analyse significant matters, and that could potentially limit the scope and depth of any audit. At the same time, the site completed process safety management compliance audits between 2012 and 2014, which lasted five times longer than a Responsible Care one. However, not even these audits were sufficient to identify and resolve process safety management deficiencies that contributed to the incident.

2 Recommendations

An audit is a very noticeable sign of interest in safety from outside of a business unit, but this can be undermined if there is no matching sign of support when audit reports call for action. At the same time, when auditors indicate no findings during audits, it is also a sign of ignoring potential problems in the system. A good balance between these extremes would support both the auditors and the leadership in the facility in advancing good process safety outcome. Guaranteeing the ability of site managers to make improvements is the most visible responsibility of leadership level management, but the main role is to oversee the health of the audit programme. To be able to do that, a robust audit programme should be in place.

If there was one recommendation how to improve and maintain adequate level of audit, managers should seek to avoid audit fatigue as too frequent audits can lead to resentment of the process and eventually ignoring the audit findings. The challenge is to make audit as part of the business and not make it a disruptive process.

The following recommendations touch some of the challenges mentioned above and are teamed around three groups to make them tailored to the different roles within an organisation. The three teams are

- managers
- process safety engineers/supervisors/auditors
- operators

as they all represent different level of responsibility and ownership in audit programmes.

Managers

Establish a robust audit program and develop process safety metrics, both lagging and leading to check the health of the audit system.
Understanding the health of an organisation's process safety management system, requires a comprehensive assessment of the content and implementation of its programs.
It is proposed that the audit should be carried out every five years. That ensures that some of those involved in the previous audit are still around and continuity has not been lost completely.
Make sure that corrective actions meet the intent of the recommendations.
It is a good practice to response to the auditor's report, including an action plan for addressing agreed non-conformances and other observations made by them.
Make sure that the audit program identifies complex issues in the facility and ensure that corrective measures are taken.
It is key that action items are tracked and effectively closed. Therefore, make sure to develop an effective system to verify that recommendations from audits are satisfactorily addressed.
Make sure that the safety report or safety case provides a description of auditing activities carried out on site.
Make sure that the resources and competent personnel required for each audit are planned and available.
Auditors need to possess a range of skills from auditing skills and the technical knowledge and experience of plant and process safety and specific technologies.

Supervisors/Process Engineers/Auditors

Make sure that you follow the audit protocols such as the use of questionnaires, checklists, open and structured interviews or checking documents and measurements and observations.
During audits, make sure to focus on actual practices, such as that operators follow operating procedures and adhere to the rules.
It is important that findings from the audit are recorded and submitted to the management for corrective actions if any non-conformances are found.
Make sure to write down all negative and positive feedback from the audit as these can be used as metrics to assess the health of the process safety management system in the company.
If you use checklist, each checklist calls for a list of action items. Such a list is only of service if the required action is taken or good reasons for cancelling it are documented. There needs to be a follow up procedure to ensure that this happens.
Make sure to be familiar with results of previous site audit findings.
During the audit, emphasise openness of the process and discuss concerns as they are identified.
Look for patterns or trends which indicate chronic problems affecting multiple areas and identify common themes.

Operators

When being audited, make sure you provide the auditors with all information about your work and any issues or difficulties that you may face. An audit is about the process, not you as an individual.
Make sure to follow operating procedures and if you discover any inconsistency in the procedures, be open about it to the auditor.
Make sure to report any major concerns to your supervisor immediately, in order to make sure that these issues are addressed.

Conclusions

As the case studies discussed above demonstrated, it is not only the responsibility of the auditors but also the site management or corporate management to ensure that audit results are neither ignored nor forgotten. In addition to that, audit findings should be shared with all sites. Audited sites should report progress on action plans following an audit, and improvements made should be noted. If an audit report makes significant recommendations and no action follows, this should be noticed by high management and investigated. Possible responses include a repeat visit by the audit team and potentially by the management in a more specialised investigation.

Other factors in an organisation and its leadership may be of greater influence in how audit findings are addressed e.g. how is the reporting system structured, clearly defined roles and reporting lines, resources available for improvement, prioritisation of audit findings and how significant ones are escalated to board level.

It is clear that, without an effective audit programme, weaknesses in the process safety management (PSM) programmes will not be identified or adequately corrected, and that could lead to lack of realisation of the full benefits of the PSM programme investment. Once an audit programme is established to verify compliance with regulation and implementation of effective management systems, it should be expanded to include an evaluation of the quality of those programmes. This last step in the audit evolution process for a PSM programme will allow quality issues to be identified and corrected so that existing PSM programmes can be effective in preventing major industrial incidents.

Fundamentally, oversight of the audit process should ensure that the audits are providing some benefit to the organisation. If no recommendations for change result from an audit, this may mean that the audited entity has achieved excellent performance in all areas, but it may also be a sign that problems are not being noticed, even in review. Be suspicious of audit reports that contain only positive findings.

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