Improving the Performance of Established PSM Programs*

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Many facilities have now implemented and maintained PSM programs for 20 years or more, but these facilities continue to have sometimes serious incidents and injuries suggesting a continuing need to improve their PSM performance. Of course, new requirements are often added to upgrade PSM programs, due to near-miss learnings, audit findings, and new Recommended and Generally Accepted Good Engineering Practices (RAGAGEP), for example, but often overall performance improvements have not occurred or have not achieved the desired level of performance. How can significant performance improvements be obtained? While performance issues at different facilities will certainly vary, this paper provides several key approaches for improving overall PSM performance and for helping prevent injuries and incidents.

Keywords: process safety management, safety culture, performance, operational discipline

Introduction

The path to sustained, excellent process safety management (PSM) performance requires a continuous journey. For most companies, PSM has been implemented for at least 20 years, due to the 1992 OSHA PSM Regulation in the U.S., the 1982 Seveso Directive in Europe, and other regulations [1]. In many companies, programs similar to PSM have been implemented for much longer periods in order to safely operate facilities containing significant process hazards [2-4]. Guidance on the design and implementation of effective PSM programs has been available for many years [1,5]. Once implemented, most companies have worked to continuously improve their PSM programs, based on near-miss or incident learnings, audit findings, new Recommended and Generally Accepted Good Engineering Practices (RAGAGEP), new technology, additional regulations, and other factors.

Yet, at a global process safety conference, one of the authors asked the basic question of how many attendees were satisfied with their PSM performance, and no one in a large meeting room raised their hand. Unfortunately, major incidents have occurred and continue to occur far too frequently [6], highlighting significant performance problems and the ongoing need to achieve better performance. The intent of this paper, therefore, is to explore some of the underlying problems that continue to contribute to poor, or less-than-desired, performance in established PSM programs and to reflect on what we can do to improve current PSM performance.

Discussion

* This is a preprint of an article published in Process Safety Progress, p. 261-265, 2012
www.interscience.wiley.com

Many companies have implemented and improved PSM systems for twenty years or more, yet they are generally unhappy with their PSM performance. What do we mean by "performance?" Dictionary definitions refer to executing actions or something accomplished. PSM performance therefore relates to executing program policies and systems with the intent of achieving program objectives. The primary objective of PSM programs is ensuring safe processes, resulting in no injuries and no major incidents. Many leading and lagging performance indicators have been developed to measure program performance [1,7-11] and have proven useful in identifying important performance improvements. The related concept of "effective" PSM programs has also been described [1,12], where effective is defined as a function of efficiency (related to resources and cost) and performance. In this paper, we focus only on the performance part of this equation, recognizing that issues of resources and cost are always present and are important considerations in any improvement effort.

Improving PSM performance has recently been an active area of interest [12-19]. Most companies now have the technical knowledge and capabilities to safely identify and manage process hazards and risks. As improved guidance and tools for implementing PSM have been developed, the focus on underlying causes of major incidents has shifted in many cases to understanding and improving organizational and cultural causes [20-23], as evidenced in particular by the Texas City explosion in 2005 [24]. Kletz [25] expressed in the early 1990s that "new" accidents rarely occur; rather the same kinds of accidents are repeated and therefore should be preventable. Lee and Harrison concluded in 2000 that at least for nuclear power stations:

> Considerable progress has been made in "engineering out" the physical causes of accidents. It is now generally acknowledged that individual human frailty and organizational defects lie behind the majority of remaining accidents [26].

More recently, Hendershot similarly stated:

> We know how to improve process safety performance. Our biggest challenge is not technical, it is cultural. We need to actually do what we already know how to do, we need to do it well, and we need to do it everywhere and all of the time [19].

It's clear that a focus on organizational and cultural issues must be increasingly important if we are to achieve significant improvements in PSM performance.

Every company, of course, has to evaluate their own operations, metrics, and performance to identify the specific issues that are important for them. As we've reviewed the literature and thought about these issues, we've identified five key areas that we think are important to significantly improve performance:

- Sense of vulnerability
- Risk management practices
- Organizational capability
- Operational discipline
- Other organizational and cultural considerations.

These areas are discussed in more detail in the following sections. In addition, a focus on strong Mechanical Integrity and equipment reliability programs is important, but is not included in this paper since other published articles are available [27-28].

Sense of Vulnerability

The starting point for a PSM program is recognizing, understanding, and managing the process hazards that are present. Any degree of complacency about these hazards, whether due to ignorance, familiarity, lack of incidents, or other causes, reduces the priority for ensuring continued excellent PSM performance. Previous strong safety performance, especially when a serious injury or incident hasn't happened for many years, is often a factor in complacency, associated with a belief that success is routine [29] rather than something requiring continued focus and diligence.

An early example of complacency issues occurred in the Bhopal 1984 incident, where many process safeguards were taken out-of-service in the mistaken belief that hazardous events couldn't occur in a process plant that was shutdown [6,30]. More recently, the Baker Panel investigation of the BP Texas City explosion in 2005 found that "… apparent complacency toward serious process safety risks existed at each of BP's U.S. refineries [24]." Further, the Baker Panel stated:

> Preventing process accidents requires vigilance. The passing of time without a process accident is not necessarily an indication that all is well and may contribute to a dangerous and growing sense of complacency. When people lose an appreciation of how their safety systems were intended to work, safety systems and controls can deteriorate, lessons can be forgotten, and hazards and deviations from safe operating procedures can be accepted. Workers and supervisors can increasingly rely on how things were done before, rather than rely on sound engineering principles and other controls. People can forget to be afraid.

While we don't advocate a return to the early days of the chemical industry, as described below, a deep and healthy respect for the hazards in the workplace is always necessary:

> Like a Damoclean sword, hanging over the head of every powder man, was the dread of explosions. It was a nameless terror, waking men at night to prowl at odd hours about the yards, observing things that would have drawn scarcely a glance from less anxious eyes – random sparks from a chimney, wind direction, faintest indication of heavy skies that might bring thunder and lightning [31].

A sense of vulnerability with respect to process hazards has frequently been identified as a key part of strong safety cultures and approaches for improvement have been discussed elsewhere [1,21,22]. A starting point is to ensure that everyone involved in the use of hazardous materials and processes develops a strong understanding of process hazards, such as toxicity, flammability, explosivity, chemical reactivity, etc., and the types of potential events that have occurred or are possible at the facility [32]. A sense of vulnerability reinforces following PSM system requirements and also helps increase the sensitivity of operating personnel to process operations.

Sensitivity to operations is an important characteristic of high reliability organizations [33] and promotes observation and troubleshooting of warning signs that often precede major incidents [34]. Efforts to improve sensitivity to operations based on an increased sense of vulnerability, therefore, help prevent major incidents from occurring. The Baker Panel also noted this as a factor in the BP incident: "there is concern that employees are not adequately skilled in 'picking

out weak signals' and are not able to deal effectively with weak signals when they do recognize them [24]."

A lack of a sense of vulnerability is also associated with normalization of deviation [35], where changes are made over time, usually to optimize cost and productivity, leading to drift in safety and potentially a slow increase in risk over time. Levenson describes it this way:

> Systems and organizations continually experience change as adaptations are made in response to local pressures and short-term productivity and cost goals… A corollary of this propensity for systems and people to adapt over time is that safety defenses are likely to degenerate systematically through time, particularly when pressure toward cost-effectiveness and increased productivity is the dominant element in decision making. Thus, the redundancy and other precautions added to protect against human error often degenerate over time as other work practices adapt to increase efficiency within the local environment. The critical factor here is that such adaptation is not a random process – it is an optimization process… [36].

A strong and continued focus on a sense of vulnerability, as supported by effective management of change systems, can help prevent normalization of deviation which leads to increased risk of serious injury and incident at a facility. Any effort to significantly improve PSM performance must ensure a sense of vulnerability in all affected employees.

Risk Management Practices

Rigorous hazard identification, process hazard assessment, and risk evaluation and management are necessary for strong PSM performance. The Baker Panel concluded, for example, that "BP's safety management system does not ensure adequate identification and rigorous analysis of process hazards… [24]." As highlighted by Hendershot and others, it's typically not that we don't know how to do this well, it's that too often it doesn't receive the importance and resources that it deserves:

> So, in the context of a PHA, what are the keys to doing a good job? I believe that the most important elements are not technical, but rather cultural [19].

It is essential to reinforce risk management practices as fundamental to a strong PSM program. Efforts to significantly improve performance should first review current risk management practices to see where gaps may exist in staffing, training, resources, and other areas. A sense of vulnerability should ensure that quality PHAs are conducted and that other risk management practices are maintained strong or improved where appropriate. Associated with this, effective management of change practices must be used to help ensure appropriate risk evaluations are conducted to help prevent deviations from desired practices, as discussed earlier. Effective incident investigation and auditing practices can also help identify potential gaps in these areas.

Many methods for evaluating risk have been used for long periods, so continual review of newer approaches that may provide new insights into process hazards and risks is also worthwhile. A lengthy review is beyond the scope of this paper, but systems engineering and other approaches [15,36,37] may prove beneficial, especially if the same methodologies have been used repeatedly for PHA revalidations and other risk assessments. New approaches may provide new perspectives and, therefore, improved risk management.

Organizational Capability

It's often recognized that it is increasingly difficult for everyone to know everything about any technical area. Organizational learning and memory, networking capabilities, and mentoring for new or less experienced personnel can improve overall organizational capability in many ways and help lead to significantly improved PSM performance. The Baker Panel noted "BP's system for ensuring an appropriate level of process safety awareness, knowledge, and competence in the organization… has not been effective… [24]."

With increasing complexity associated with manufacturing processes, continuous addition of new PSM requirements, continued development of new RAGAGEP and regulations, and potentially increased staffing turnover expected in the future, a focus on organizational learning and memory is essential [38]. Further, the ability to network within a large organization to locate and use knowledge experts is often required due to the wide range of PSM requirements, process operations, and problems that can arise [39]. To support less experienced people, or those in new roles, mentoring relationships can be established to promote more rapid development of knowledge, identify expert resources, and help sustain safe day-to-day operations.

Use of effective training strategies to develop basic PSM and other technical knowledge and capabilities within the organization must be a priority. The Baker Panel noted:

> BP has not demonstrated… a comprehensive and integrated education and training program that adequately defines the required education and competency levels for all levels of the refining personnel and managers. Training generally appears to include a number of unrelated training events rather than an integrated program [24].

A well-defined training strategy should be developed and implemented, with refresher training provided at appropriate intervals. A focus on identification, understanding, and assessment of process hazards should be included as discussed earlier. Additional training must be provided for reinforcing a priority for safety, explaining the design and implementation of PSM systems, ensuring good risk management evaluation, promoting safe day-to-day operations, and providing for basic job skills as required to support strong PSM performance.

Operational Discipline

Operational Discipline (OD) is the commitment of everyone in an organization to rigorously follow established systems, procedures, and practices [40,41]. Once a strong PSM program has been implemented, the greatest opportunity to maintain and improve performance often lies with OD, especially as supported by efforts to ensure a sense of vulnerability and overall organizational capability. The Baker Panel noted, for example:

> Instances of a lack of operating discipline, toleration of serious deviations from safe operating practices, and apparent complacency toward serious process safety risks existed at each of BP's five U.S. refineries [24].

If people are not following system requirements, at all levels of the organization, then poor performance will result and the risk of serious injury and incidents necessarily rises. Of course people make mistakes, so systems should ensure development of good operating procedures, strong training programs, and use of tools such as checklists to minimize the potential for error, especially where serious injuries and incidents are possible. How to evaluate and improve OD is

beyond the scope of this paper and is discussed elsewhere [40-43], but a focus on OD is required for achieving strong PSM performance. As discussed by Jim Collins in *Good to Great*: "Sustained great results depend upon building a culture of self-disciplined people who take disciplined action… [44]."

Other Organization and Cultural Considerations

This section is a "catch-all" for other organizational and cultural issues at a facility that can impact PSM performance, where different locations may have somewhat different priorities that must be identified and pursued. A range of possibilities exist as outlined in the many sources on this topic [1,21-23]. There could be a fundamentally-poor balance of safety and production priorities on a daily basis, at least by some members of supervision. It could be poor "felt" leadership where line leadership fails to demonstrate a personal priority or provide resources for a strong safety culture. Identifying these additional elements is essential to support the factors previously discussed and to ultimately achieve significantly-improved PSM performance.

In training PSM resources on how to be effective, we emphasize that they have the expertise and responsibility to make leadership aware of concerns that can lead to injuries and serious incidents: they simply cannot be organizational bystanders [45] or use mitigated communication [46] when the plant may possibly blow up. This presumes openness on the part of leadership for this input and a basic belief that hazardous processes must be proven safe to operate [34]. Therefore, accessibility and good communication of qualified PSM personnel with leadership is essential, cited as "deference to expertise" in high reliability organizations [33].

In some cases, existing leading indicators may not prove particularly useful, because current performance based on management attention has been excellent. If leading indicators are basically zero, they lose value except for noting (hopefully) rare occasions when something, such as a maintenance test, doesn't get done on time. In these cases, a focus on developing additional performance indicators, perhaps emphasizing some of the organizational and cultural factors discussed in this paper, can add value in monitoring PSM performance [1,7-11].

Implementation

PSM auditing does not necessarily evaluate the organizational and cultural PSM performance factors highlighted in this paper very well, although this may vary from one company to another. This may be partly why injuries and incidents continue to occur despite repeated audits by qualified auditors. Certainly, PSM audits establish a baseline of performance by careful review of site system design and implementation, based on regulations and company PSM requirements, but auditing organizational and cultural factors is generally more difficult. PSM audit protocols can be revised to do a better job of this going forward, perhaps using additional evaluations and tools, such as employee surveys, to gain a better perspective on possible deficiencies. The first part of fixing a problem, of course, is identifying it, so improved audit processes may be needed.

In order to supplement PSM audits, rapid assessment teams comprised of senior, experienced PSM and operations resources, can conduct specialized audits at sites based on the organizational and cultural factors considered most important for strong performance. The narrow scope, as

compared to a comprehensive PSM audit, for example, can provide stronger focus on specialized topics and more time and depth for review of critical performance factors.

The results of rapid assessments can be combined with other assessment tools, such as site self-assessment surveys, to provide a basis for "PSM Performance Accelerator" workshops at the site to introduce key performance parameters, to review issues that have been identified, to consider priorities for future work, and to develop specific improvement plans based on the local site needs. Higher level leadership support and expectations for progress against the plan as well as continued mentoring by senior PSM resources to support plan implementation and follow-up are desirable. As progress is made, new priorities can be identified to continue the journey to significant improvement in PSM performance.

Summary

PSM Programs have been implemented for 20 years or more at most companies, based on regulations and the inherent need to safely manage process hazards. Generally speaking, industry knows how to design and implement the technical side of PSM programs, which often have literally thousands of program requirements, based on regulations, RAGAGEP, and other guidance. Yet, despite continuous improvement of program requirements, industry continues to have performance problems, sometimes resulting in serious injuries and catastrophic incidents. Sustained, excellent PSM performance requires a commitment to zero injuries and serious incidents, strong systems, and increased focus on organizational and cultural factors that impact performance. To achieve a step-change improvement in performance, PSM programs must target these organizational and cultural factors that, while ultimately harder to work on due to various human factors, present the greatest promise of enhanced performance.

This paper identifies several key performance factors that are necessary for achieving higher levels of PSM performance – sense of vulnerability, risk management practices, organizational capabilities, operational discipline, and other organizational and cultural considerations. Ultimately, of course, each company, in fact each specific facility, must evaluate their own operations, metrics, and performance to identify the specific issues that are important for them. Likely, if they have a well-established PSM program, significantly improved performance will likely require a focus on at least several of the key organizational and cultural factors discussed in this paper. We welcome thoughts on other important parameters as well.

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