

Process Safety Management

Are your Facilities as Safe as you Claim?



From our strategic safety reviews and independent process safety management (PSM) system audits, we continue to identify significant weaknesses in PSM performance that are not always visible to senior management. Failure to detect and understand the severity of these key PSM weaknesses can result in inappropriate and poorly targeted safety-related investment. These investments can therefore fail to reduce the facility's risk profile, ultimately leading to a negative impact on the bottom line, together with potential for harm

We attribute these weaknesses in PSM performance to several factors:

- Years of "performance improvement" initiatives, resulting in more severe operating conditions, more outsourcing of inspection and maintenance, increased pressure to keep assets in service and longer intervals between plant shutdown and turnaround.
- Weak "board-level process safety leadership", resulting in unclear ownership and accountability for process safety within the organization's management hierarchy. Cascade effects include failure to "challenge the status quo", define minimum process safety performance expectations, enforce systematic risk assessment, and engage the workforce in process safety and operational excellence improvement initiatives.
- Reduction in manning levels. As older, more experienced employees opt to take early retirement, a gradual loss of knowledge can result, especially where there is a limited pool of suitably qualified personnel available for recruitment.
- Poor operational experience of HSE personnel, combined with poor hazard awareness and process safety competence of operational personnel. This results in ineffective challenging of existing practices and weak management of process-safety risks.
- Failure to develop meaningful process-safety indicators and infrequent major accidents. This combination has fostered a tendency to focus on improving occupational safety performance (reducing slips, trips and falls), which distracts

management's attention and can too often result in weaker PSM practices.

- A tendency to generate large amounts of unnecessary paper (procedures, checklists, etc.), which may satisfy regulators and auditors, but does not support operators (whose needs are practical rather than formal or legal).

Some of the above can be attributed to the ever-greater pressure from shareholders to maximize short-term bottom-line performance – placing pressure on existing asset operating margins and requiring companies to minimize operating, maintenance and capital replacement costs. This can, in some cases, even result in facility managers postponing what are too often seen as "nice-to-have" process safety investments as they continually seek to reduce costs without understanding the process safety risks.

Driven in part by safety regulators and insurers, the process industry sector has implemented a number of safety investment initiatives to address lessons learned from past major accidents. These have undoubtedly had a positive impact on asset safety performance. But they often come too late – after loss of life, damage to assets and business interruption. These major accidents highlight how failure to invest properly in PSM is a false economy. The business costs of disruptions, outages, unplanned closure and accidents can be severe.

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The following anecdotes illustrate aspects of what we see as ineffective PSM.

Potential hazards not recognized

At one facility we audited, line managers appeared to put their trust in one procedure – “All units on site have been subject to Process Hazard Analysis Study [HAZOP or similar]” – whereas our audit of the facility revealed these studies were more than five years old and of poor quality.

In one study an operating scenario resulting in a major hazard (runaway reaction) was described as “no significant issue” and “no protections listed.” We also know from an investigation by the US Chemical Safety Board that failure to recognize the potential for initiation of a runaway reaction lay at the root of an explosion and fire that killed four employees and injured 32 others in December 2007.

Poor implementation of study recommendations

At another facility where the management view was “Process safety risks have been identified and are managed,” we found that a satisfactory HAZOP had been completed two years earlier. Yet, for some 80% of the recommendations, neither a party responsible for implementation nor a deadline for completion had been set. Implementing the recommendations was seen as neither important nor high priority, even though failure to implement one of them led to a severe mechanical failure and outage of a major plant for three months.

Continued operation of “life expired” and significantly degraded assets

In one E&P company, various operational, maintenance and inspection engineers reported continued operation of “life expired assets,” which presented significant safety hazards to personnel or potential for major release and fire. Examples cited included unsafe HV switchgear, unmanned platforms with significant wellhead corrosion and casing leakage, and deferral of inspection activities on equipment given “operational criticality.” These unsafe conditions were confirmed by line managers, along with additional fundamental process safety failings that were identified during safety inspections, such as degraded electrical junction boxes located in hazardous areas and a manned platform with the standby firewater pump out of service for a sustained period due to spares availability.

Acceptance of “non-compliance” and ineffective line management

At a refinery we found the work permit procedure required double block and bleed for the isolation of all process lines and equipment. However, when we toured the facility, we noticed that a bottom pump for a vacuum column had been removed for maintenance several days before; the only means used to isolate hydrocarbon above its auto-ignition temperature was a single valve in a closed position without any tag or lock.

We know of one instance in which failure to provide double block and bleed for isolation (as recommended in a HAZOP study conducted earlier) resulted in an uncontrolled leak of heavy hydrocarbon, with significant environmental impact and a one-month loss of production.

Protective arrangements not in service

At a petrochemical facility the management of change procedure required shutdown trips to only be bypassed for a short time, subject to formal authorization by the production manager, and then only after identification and implementation of alternative risk-control measures. However, during our audit we found that over 20 shutdown trips had been bypassed from the control panel for an unknown length of time, without any notification or approval. In each of these, the fundamental protection provided by the emergency shutdown trip had been decommissioned without management’s knowledge.

Rationalization of fire-fighting equipment

At one tank farm we visited, the dedicated fire-water pump and tank had been decommissioned and replaced with a tie-in to the adjacent refinery system. However, this resulted in a 15-minute delay to fire-water availability, as well as insufficient pressure and capacity, increasing the potential for event escalation and ineffective fire-fighting response in the event of a major incident.

In our view, situations such as these represent significant failures of a PSM system and management team.

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The way forward

In our work with leading international operators of major process hazard facilities, we have found that a surprising – and increasing – number are down playing the real challenges they face in the design, implementation and monitoring of an effective PSM system.

Many operators have invested heavily in engineering measures. Yet only a select few have made significant progress in understanding their key process safety risks, implementing effective control processes and proactively monitoring process safety performance.

In our view, five key challenges should be addressed to ensure that PSM systems meet operator needs.

1. Develop an up-to-date, comprehensive process hazard picture for all operating assets

The process hazard analysis report should form the central pillar of the PSM system for each site. The process hazard analysis needs to be comprehensive and based on up-to-date process safety information (such as as-built piping and instrumentation diagrams). The study should include participation of either the licensor (for a new asset) or experienced operators (for an existing asset).

Where significant safety hazards are found, existing risk-mitigation controls and any associated recommendations for improvement need to be included in facility corrective action and budgetary-planning programs. Information on hazards and risk controls should be introduced into appropriate facility documentation (such as operations safety instructions and operating and emergency procedures), inspection and maintenance regimes and employee training programs.

2. Ensure that key risk-mitigation measures are implemented on site and subject to regular performance testing

Regular facility process safety audits, inspection, maintenance and performance testing programs need to provide the management team with the assurance that facility PSM programs remain implemented, functional and available. Specific attention should also be given to testing of safety-critical protections (e.g. blowout preventers) and ESD trips. In many process safety audits we find a disconnect between the findings of the process hazard analysis studies and actual facility practices, including performance testing and reporting.

3. Develop HSE competence of management teams and reinstate line management responsibility for safe operation

Strengthening HSE competence of the management teams and creation of “visible felt leadership” provide a critical foundation to a more proactive and innovative culture. This supports the cascade of HSE through all levels and functions of the organization, ensuring that HSE becomes an integral part of all conversations.

Development of line manager and supervisor HSE competence and communication skills can have a disproportionate impact on HSE performance, given their role in ensuring effective implementation of the PSM system requirements and developing values, attitudes and behaviors of both employees and contractors.

4. Review occupational and process safety performance data at board level and promote upward reporting of bad news or safety concerns

So-called key performance indicators (KPIs) based on “completion of activities against plan” provide limited insight into safety performance. Reporting practices that “collate and average” safety performance across various units in a complex and/or different complexes in a group tend to camouflage highs and lows in safety performance. Facility-specific issues tend to be lost, and the spotlight is turned away from specific potentially hazardous circumstances that really need attention.

In our view, KPIs should ensure that the individual facility risk and safety performance picture is transparent. For such indices to be effective, the safety culture at the facility needs to be open and supportive to ensure that people feel able to report safety concerns without fear of repercussion. Furthermore, the leadership team needs to continually challenge the results, especially “green KPIs,” to ensure that they represent the actual performance of significant risk-control measures.

5. Understand how corporate business decisions impact asset process safety

Although many organizations benchmark asset performance in terms of operational data sets (such as scale, technology configuration, complexity, efficiency, manpower level, financial performance, maintenance cost and so forth), few organizations have specific proactive process safety KPIs.

Process safety KPI examples include:

- Frequency of activation of safety alarms and/or safety interlocks (to indicate stability of operation and proximity to unsafe operating conditions).
- Percentage of urgent repairs or planned predictive maintenance on critical rotating equipment that are completed on time.
- Mechanisms for regular measurement of employees' compliance with safety procedures and implementation of safety systems of work (an indication of safety culture).

In some cases, we find facility managers have an understanding of the safety benefits of a proposed investment, but this gets lost in the transfer to corporate decision-making, in which investments are being allocated across a broad spectrum: different business areas, new asset investment and existing assets. This is often due to the fact that the proposed safety investments are not backed up by a benefit-cost analysis, highlighting both the safety improvement and the savings associated with averted loss of property and production.

Without the implementation of proactive process safety KPIs, it is not possible to measure the impact of any investment decision or initiative on process safety performance. As a result, business decisions (such as secondary investment activities around inspection, maintenance and manpower resources) can be made that actually raise, rather than lower, the asset risk profile.

Process safety management

Arthur D. Little is able to draw on a wide breath of process safety management knowledge obtained from first-hand experience working with operators in Africa, North and South America, Europe, the Far East, and the Middle East, across a wide range of process-industry sectors:

- Upstream Production
- Refining
- Petrochemical and Speciality Chemicals
- LNG Liquefaction, Storage and Re-gasification
- Transmission Pipeline Systems

If you would like more information, or to arrange a discussion about the issues raised here and how they affect your business, please do not hesitate to contact us.

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Arthur D. Little

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