

Safety Performance Improvement using Cultural Change – Lessons Learned

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The process industry has used formal management systems to pursue process safety improvements for over 20 years. Yet, data and experience reveal that few companies have fully mastered it and can claim sustained high levels of HSE performance improvements over long periods. Some companies/facilities have had cyclic performance, others have had reasonably good performance, but they have plateaued and have been unable to really continuously improve.

One reason for this is that current PSM auditing and root cause analysis (RCA) practices sometimes don't go far enough. PSM audits generally issue findings and areas for improvement "at the element level" even though the evidence used may point to deeper problems. Incident investigations identify PSM elements as root causes but don't address safety culture factors. Use of PSM leading indicators is broadly accepted, but their use for performance management is in the "infant stage." There are plenty of learning opportunities; we need to adjust our learning and performance improvement approaches.

To break the status quo, companies are encouraged to focus on managing performance of process safety, not simply compliance of process safety. To do that, we have to take advantage of all of our learning opportunities and dig deeper "further down the accident pyramid" in to the realms of safety culture.

Over the last 10 years we have performed Process Safety Culture evaluations and change projects for over 40 companies globally. In each case the safety performance has been monitored to identify causal links to cultural interventions. This has given us an almost unique understanding of the relationships between safety culture and actual performance. This paper summaries the findings of these studies and presents our experiences relating to:

- Measuring safety culture
- Which PSPIs make a good leading indicators for culture
- The most effective cultural change strategies – the quick wins
- How to make cultural change and performance improvement programmes sustainable
- Early recognition of culture degradation
- Ensuring that incident investigations extract the cultural root causes and to cross-correlate these with audit findings

Introduction

When considering safety performance, it is helpful to visualise it using a generic Process Safety Triangle as depicted in Figure 1, which is based on API (RP) 754 (2016). The theory being that the number of incidents in each tier of the triangle is quantitatively linked to the other levels, similar to the concept first proposed by Heinrich (1931) for industrial safety. Therefore, if the number of Process Control Issues can be measured and reduced then the number of Near Misses should reduce and so on. Implicitly, any recommendations or actions made to correct items related to the lower tiers of the triangle tend to be more proactive and preventative. Therefore, the aim of any incident investigation should be to identify recommendations as low in the triangle as possible.

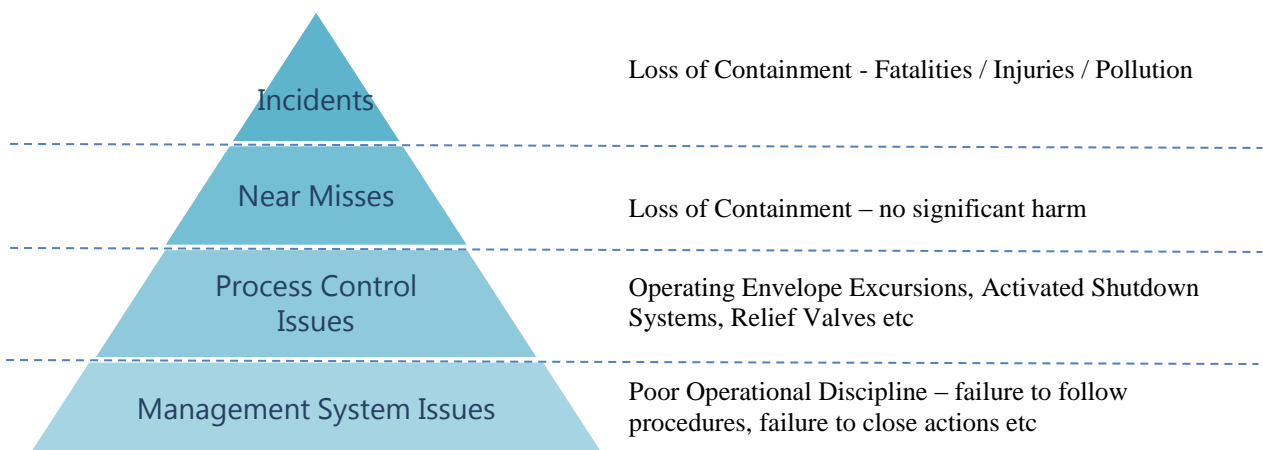


Figure 1 – Process Safety Triangle

Despite following the safety triangle model (Figure 1) many companies wonder why they keep experiencing safety problems or can't answer why their safety performance has plateaued. Incidents still occur but they seem to be unrelated to previous incidents and therefore actions tend to address the re-occurrence of that particular issue. In these cases the issue is likely to be related to their safety culture. This is the individual and organizational "DNA" that represents our tendency to want to do the right thing, in the right way, at the right time, and ALL the time – even when no one is looking.

Safety culture has been a concern of the HSE for a long while and was eloquently summarised by Dame Judith Hackitt when the Chair of the HSE (Hackitt, 2015).

“One topic that is equally relevant to all industries is this need for leadership of health and safety from those at the top of an organisation, creating a culture throughout the whole organisation where everyone understands their role and everyone wants to get health and safety right.”

It is commonly accepted that culture affects safety performance so it should therefore sit within the safety triangle. The model that ABS Group (ABSG) promotes is that safety culture is the foundation of safety performance and can be depicted as shown in Figure 2.



Figure 2 – Organisational Culture in the Extended Process Safety Triangle

A poor organisational culture will affect the implementation of the Management System, which will lead to more process control issues etc, up through the tiers of the safety triangle.

However, the linkage between the culture tier and the higher performance tiers is generally seen as qualitative and defining quantitative cultural Process Safety Performance Indicators (PSPIs) has proved a challenge. Companies can measure and benchmark cultural features, but it can be difficult to prioritise which ones to focus on, and then even more difficult to link each culture change initiative to performance. Measuring culture can also be a time consuming activity, and as culture can take a while to change, repeatedly measuring it without perceived improvements can be detrimental and undermining to the improvement process.

To effectively manage process safety using the extended process safety triangle in Figure 2 an organisation needs to grasp three important aspects of safety management.

- 1) Becoming a Learning Organisation
- 2) Implement robust Safety Management Systems for assurance of Process Control
- 3) Embed an appropriate Safety Culture

To become a learning organisation a company needs an effective Incident Investigation and Root Cause Analysis process. An effective system will make recommendations to treat the underlying issues in process control and the management system. To ensure that control processes and the management systems are well implemented organisations measure leading PSPIs and perform audits. If we accept Organisational Culture as the underlying cause then corrective actions need to penetrate to the lowest level of the safety triangle, as depicted in Figure 3. However, it can be difficult to make the causal link between the performance issue and a specific cultural feature.

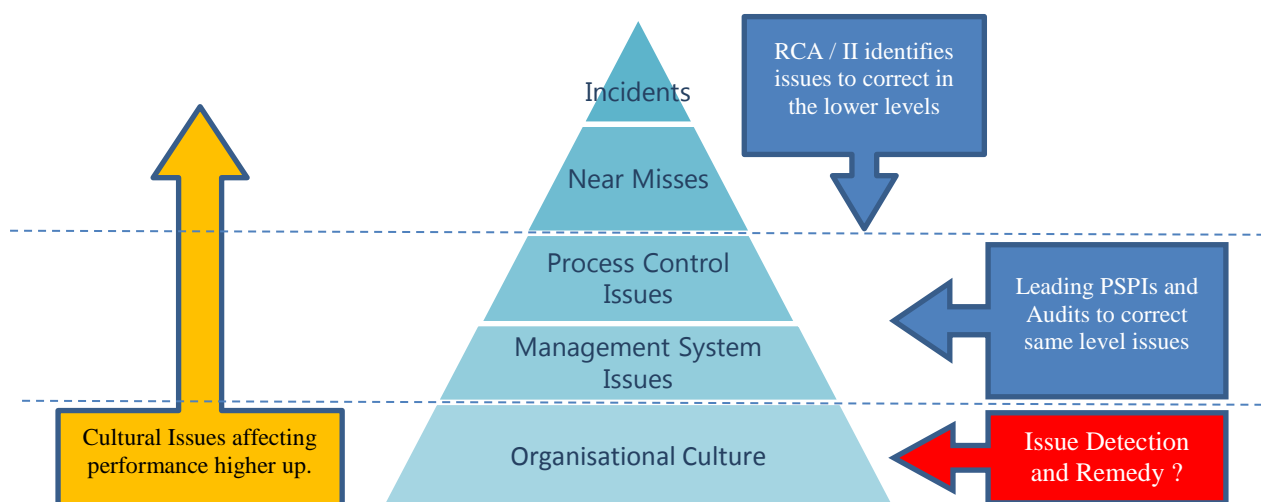


Figure 3 – How to Identify and Remedy Cultural Issues in the Process Safety Triangle ?

Our logic is that poor safety culture will permeate upwards into unsafe behaviours in the tiers above and then appear in the PSPIs; this is shown schematically in Figure 3.

The questions that Figure 3 then invites are:

- 1) How to measure safety culture?
- 2) Are there correlations between the culture factors and the leading and lagging PSPIs that a company is recording, and
- 3) Is it possible to use this correlation to identify the elements of the process safety culture that need addressing first?

Measuring Culture

There are a large number of different frameworks that can be used to measure and subsequently drive improvements in safety culture. No matter where these come from they all tend to cover the same issues, as per the RBPS Guidelines, published in the US by the CCPS (CCPS & ABS Consulting, 2007). Table 1 lists these elements, together with their inverse, which would be the observable symptoms if it were not present; this is the framework that ABSG generally uses for culture assessment work.

Table 1: Essential Features of Process Safety Culture, and some Symptoms when Absent

No	Essential Feature	Symptom that feature is absent
1	Establish safety as a core value	Production takes priority. Units restart before the Pre Start-Up Safety Reviews (PSSRs) are fully signed off. Awards and praise for high production, but none for safe behaviour.
2	Provide strong leadership	When the CEO comes on-site, discussions are with the site leadership team. He/she doesn't pull on PPE and ask front-line staff about their process safety risks. Site managers don't perform weekly safety visits; picking up litter is beneath them
3	Establish and enforce high standards of performance	Normalisation of deviance: individuals not following Standard Operating Procedures; this behaviour is "accepted", goes unnoticed and is not commented on. Site procedures not updated within specified time frame. Housekeeping issues. Individuals not using all required PPE all the time. Incomplete attendance of refresher training (and no follow-up).
4	Formalise safety culture emphasis/approach	No formal discussions on process safety culture. Process safety not mentioned on internal and external company web pages. (Process) safety not included in staff surveys. No recent in-house training on process safety.

No	Essential Feature	Symptom that feature is absent
5	Maintain a sense of vulnerability	No "chronic unease". Individuals cannot answer "what is the worst case scenario for your area?" or "If everything goes wrong, what is the maximum number of fatalities that could arise, and why?". "We've done it this way for 30 years and nothing has happened".
6	Empower individuals to successfully fulfil their safety responsibilities	No-one on the leadership teams (board/senior management team/site leadership team) "owns" process safety issues. No-one has hit the "big red button" in the last three years.
7	Defer to expertise	Burden of proof demanded on safety statements and comments. Changes implemented without asking "the guru".
8	Ensure open and effective communications	Town Hall meetings aren't held or get postponed regularly. Minimal reporting of near misses and minor accidents. Front line staff not asked for their opinions. People stop reporting safety issues because "nothing will happen anyhow", and they won't get feedback.
9	Establish a questioning and learning environment	"I just do what I'm told". No challenging of instructions. Operators can't remember the topic of the last Safety Standstill/meeting. Reasons for most recent incident not understood by all operators.
10	Foster mutual trust	Near misses not reported for fear of being blamed. Reporting a near miss perceived negatively.
11	Provide timely responses to safety issues and concerns	Reported safety issues just get added to an ever-growing list. They disappear in to a black hole. Slow progress on resolving safety actions from RCAs after safety incidents. Status of progress on safety actions from RCAs not shared with all.
12	Provide continuous monitoring of safety performance	Process Safety KPIs not collected and shared with all on site. No structured management review of (process) safety performance

Which ever culture framework is used the typical ways to get a handle on process safety culture are:

- Employee surveys
- Employee interviews
- On the job observations
- Process safety indicators, both leading and lagging.

Surveys are useful but cannot be conducted more frequently than once a year. Survey questions are developed to see how employees "feel" about process safety-related matters. Participants respond in the range of strongly agree to strongly disagree to a series of questions. The outcomes can then be regrouped in categories relating to process safety (reporting PS events, management commitment to PS, procedures, workplace involvement, training, etc.). And even then the outcomes are often influenced by other issues such as staff morale at that snap shot in time. Nonetheless, provided the sample size is large enough then it should be possible to gain useful information from the typical questions asked.

Interviews are another way to put a finger on the process safety culture. An obvious problem with using them is the costs involved and the results are often difficult to classify versus an existing framework.

Work observations. Observing operators and technicians may be useful but has clear downsides of the behaviour of the individuals changing if they become aware they are being observed. And again, the costs of this approach will be significant.

Process Safety Performance Indicators (PSPIs). All responsible companies will have a set of both leading and lagging PSPIs. A difficulty is correlating the different PSPIs against the different features of safety culture. This is needed in order to prioritise the elements to address first.

What do Cultural Surveys Reveal?

ABSG has conducted safety culture assessments with more than 40 companies globally involving hundreds of individual facilities and tens of thousands of surveys and interviews. Table 2 presents results for fourteen Oil, Gas and Petrochemical facilities where we have conducted cultural assessments against the 12 Essential Features in Table 1. The motivation to undertake the culture survey in each case was concerns over recent incident trends e.g. increasing levels of Incidents and Near Misses.

Table 2: Qualitative Comparison of Process Safety Culture Results

	Essential Features											
	Establish safety as a core value	Provide strong leadership	Establish and enforce high standards of performance	Formalize the safety culture emphasis/approach	Maintain a sense of vulnerability	Empower people to fulfil their safety responsibilities	Defer to expertise	Ensure open and effective communications	Establish a questioning/learning environment	Foster mutual trust	Provide timely response to safety issues and concerns	Provide continuous monitoring of performance
Small												
Company 1	OI	M	M	S	S	M	M	M	M	OI	OI	S
Company 2	M	M	S	S	S	S	S	S	S	S	S	M
Medium												
Company 3	S	M	OI	M	S	OI	M	OI	M	OI	M	M
Company 4	OI	M	M	S	OI	M	M	OI	S	OI	S	M
Company 5	S	M	OI	M	M	S	OI	S	OI	S	OI	M
Company 6	OI	OI	OI	OI	OI	OI	OI	OI	OI	OI	OI	OI
Company 7	OI	OI	OI	OI	OI	M	OI	OI	M	M	M	OI
Company 8	S	M	OI	M	OI	M	M	M	OI	M	M	M
Company 9	S	OI	M	S	M	M	S	M	S	M	M	M
Company 10	OI	OI	OI	S	S	OI	OI	M	OI	OI	OI	M
Company 11	OI	OI	OI	S	S	OI	OI	M	OI	OI	OI	M
Large												
Company 12	OI	S	OI	S	OI	S	OI	S	M	S	M	M
Company 13	M	OI	OI	S	S	M	M	S	M	S	M	M
Company 14	M	OI	S	S	S	M	M	M	M	M	M	S

S = strength (green cell), M = moderate (yellow cell), and OI = Weakness or Improvement Opportunity (pink cell).

Observations from this representative data set include:

- 1) All companies indicated room for improvement in several elements, but there is no indication of which essential feature to address as a priority.
- 2) Strong Leadership scored as “moderate” or “improvement opportunity” across all but one of the facilities. As these companies were experiencing poor performance there could be a bias in the results as the Leadership team is blamed.
- 3) Surprisingly, a formal approach to safety and a sense of vulnerability scored well, even though other features for the same company scored lower.
- 4) Poor Leadership appears to be correlated with poor enforcement of high standards and a lack of continuous monitoring of performance. Does this point towards a causal linkage between these cultural features and PSPIs?

Because of the underlying differences in culture assessments in general, it is challenging to compare the results from one assessment to another and draw meaningful conclusions from the comparison. Indeed, the greatest value of any culture assessment is to first provide a baseline for the facility and then mark progress over time in subsequent assessments at the same facility using the same methodology; effectively “benchmarking” a facility against itself.

Linking Culture with Performance

If a site or company is interested in the state of their Process Safety culture then the obvious assumption is that they wish to improve it. All sites and companies are, by definition, working flat out all the time. Implementing improvements in their

process safety culture will then need to fit within the existing work. Either that or something else will have to stop being performed. What this really means is that it is not possible to address all of the possible issues regarding the culture simultaneously. And even then some of the issues may already be in a good state and so not need further improvement. The important thing then is to have a means of prioritising the areas, and so then the actions to be taken. In other words what is needed is a mapping between the available data. This is done by cross-correlating the results from the culture analyses (surveys, interviews and observations) with the safety performance data.

In our experience the following list can be considered to be cultural indicators, and forms the basis for collating the safety performance data used in the cross-correlation process. It is important that PSPIs and the findings of audits and incident investigations map to these cultural indicators.

- Containment integrity issue allowed to exist
- Unsafe work practice
- Action item not completed or late
- Safety hazard situation is allowed to exist
- Inadequate inspection, testing, maintenance
- Inadequate management practice/ system / procedure
- Inadequate hazard, risk, root cause analysis
- Inadequate monitoring or auditing
- Inadequate training
- Inadequate recordkeeping and documentation
- Inadequate communication or signage

At a basic level, increases in the frequency of these types of issue are an indication of a cultural degradation. As risk significance reduces down the list, increases in frequency towards the bottom of the list gives an early warning cultural degradation.

Assuming the company has a range of performance data available and has conducted an exercise to benchmark their safety culture then the survey results and the technical results can be mapped to the 12 Essential Features of Process Safety Culture. The weighted contributions from survey results and from the performance data can then summed to give a score for that essential feature.

ABSG has devised such an approach for connecting process safety culture survey results to process safety outcomes. This process safety Performance Assurance Review approach (Figure 4) categorizes the culture survey results and maps them to the 12 essential features of a good process safety culture, (b) categorizes the results from a review of recent and historical process safety performance at a plant (e.g., current PSM or EHS audit results) and maps these results to the same 12 essential features. The “weighted outcome” of the mapping of contributions of both the survey results and the performance data to the 12 essential features are totaled and the most significant process safety culture issues are identified for the plant/company.

Safety Culture Essential Features:						Safety or the permit-to-work state	Strong safety leadership	High performance standards	Safety culture framework / structure	Sense of urgency	Individual empowerment	Defence to expertise	Open and effective communication	Questioning/ learning environment	Mutual trust	Responsiveness to safety issues	Continuous monitoring of performance
Scores from Survey Results of Dataset : 01						71%	73%	73%	71%	68%	76%	62%	68%	55%	70%	76%	66%
Safety Cultural Performance Ranking						4	4	4	4	4	4	6	4	6	4	4	4
Plant 1 Dataset						EHS Technical Performance / Culture Evidence to Process Safety Culture Factors											
Audit Findings	Consequence Level	Severity Adjustment Factor (1-4)	Risk Rating	Risk Category													
Containment integrity issue allowed to exist	0	50	0.0	0	0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unsafe work practice	0	25	0.0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Action item not completed, late, or chronic	0	25	0.0	0	0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Safety hazard situation is allowed to exist	0	20	0.0	0	0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inadequate maintenance, inspection, testing	4	20	2.0	40	6	0.5	2.4			0.5		0.7		0.7			2.4
Inadequate management practice / procedures / system	2	15	3.5	53	25	2.0	10.0		10.0	2.0		2.0					2.0
Inadequate hazard, risk, or RCA review / analysis	9	15	3.5	53	25	2.0	10.0		2.0	10.0	2.0	13.0		10.0			2.0
Inadequate monitoring or auditing	1	10	1.5	15	4	0.3	1.6	0.3	1.6	0.3	0.3			2.4	0.3		1.6
Inadequate training	3	10	3.0	30	6	0.5	2.4		0.5	0.5	2.4	0.7		0.7	2.4		
Inadequate recordkeeping and documentation	1	5	1.0	5	1	0.1	0.4									0.1	0.1
Inadequate communication or signage	1	5	2.5	13	1	0.1	0.4				0.4		0.4	0.1	0.1		
UPDATE COLORS					Priority Guide:	3	2		2	2	3	1	3	1	3		3

Figure 4 – Cross correlating Culture Survey data with PSPIs

If all goes as planned then there will be no surprises between the culture survey opinions and the PSPI results, i.e. by the actual historical performance in the field. The outcome is then a simple ranking for the quality of each of the essential features in the company (Table 3 provides an example outcome for a particular company, expressed as inverses of the essential features in Table 1). This ranking should then provide the causal link between the safety culture and the safety performance, with the worst issues ranking highest.

Table 3: Example of the ranking outcome from cross-correlating culture survey results with PSPIs

Process Safety Cultural Causal Factor	Ranking
9. Lack of a questioning/learning environment	1
12. No performance monitoring/pursuit of improvement	1
5. Lack of sense of vulnerability	2
7. No deference to expertise/burden of proof on safety	2
11. Non-responsiveness to safety concerns	3
3. Normalization of deviance	3
2. Lack of strong process safety leadership	3
1. Process safety is not a core value	4
4. No formalization of a “culture process”	4
8. Ineffective communications	4
10. Lack of trust – unsafe reporting environment	4
6. Lack of personal responsibility for process safety	5

From this example, the lack of a questioning/learning environment and a lack of monitoring of process safety performance/pursuit of continuous improvement are main issues for this company when cultural features are cross referenced with PSPI information. But the company doesn't need to do any further work in the short term on fostering mutual trust or empowering individuals to fulfil their safety responsibilities because the PSPI/culture links indicate that they are in a relatively good state of health.

Comparison of Corporate Process Safety Cultures

Not all companies are mature enough to provide the required PSPI information, however, sufficient data were available for a number of these companies to complete the ranking as per Table 4. The scores for each element were summed over the nine companies and then sorted in descending order (the top is the worst performing) as shown in Table 4.

Table 4: Ranking of the Essential Elements of Nine Different Companies based on PSPI Cross Correlation

Process Safety Culture Problem	Company								
	A	B	C	D	E	F	G	H	J
Normalization of deviance	1	1	4	2	1	2	7	1	2
Non-responsiveness to safety concerns	3	8	3	3	7	1	3	3	3
Lack of a questioning/learning environment	4	5	7	5	3	3	2	4	5
Lack of trust – unsafe reporting environment		6	1		10	5	5	7	6
Lack of personal responsibility for safety			8			9	9	8	9
Not listening to technical experts		10	6		9	8	1	6	4
No performance monitoring or pursuit of improvement	2	9	9	1	2	4	4	2	11
Lack of sense of vulnerability	5	2	5	4	8	7	8	5	7
Ineffective communications		11	2		11	6	6	11	10
Process safety is NOT a core value	6	3	12	6	5	10	10	9	8
Lack of strong PS leadership	7	7	11	7	6	11	11	10	1
No formalization of culture process		12	10		12	12	12	12	12

Some conclusions from this comparative exercise:

- There was a general consistency in the ranking of the issues (Table 4 has roughly three bands with the poor elements being poor elements in all companies; the same for the good elements).
- Normalisation of deviance, and the feature itself “Establish and enforce high standards of performance” scored very poorly in almost all companies. This was also the case in the cultural survey results and now backed up by the cross correlation to PSPIs.
- These companies were experiencing safety performance issues towards the top of the process safety triangle, i.e. Incidents and Near Misses. Although it may be intuitive to address operational discipline issues, (normalisation of deviation), this data also indicates that “Establishing a questioning and learning environment” and “Timely Response to Safety Concerns” are also important in this case.

Conclusions and Lessons Learned

Cultural change takes time to implement and we are continuing to work with companies to monitor on going safety performance over time. To date the following lessons have been learned.

- 1) Cultural surveys are good for setting a benchmark for an individual company to measure future improvement against, but offer little insight into where the “quick wins” are.
- 2) Improvement in most cultural features will bring performance benefits in time.
- 3) Normalisation of Deviation is the key issue in the majority of companies we have worked with
- 4) There is growing evidence to postulate causal links between cultural features and process safety performance (PSPIs). Based on the work we have done to date in this area our thoughts on this summarised in Figure 5.

Considering the process safety triangle in Figure 5. The majority of cultural features support the foundations of the safety triangle, such as safety as a core value, empowering staff, mutual trust, open and effective communications etc. However, our studies have indicated that if a company is having issues with process control than they should consider focusing on the items in Table 5 as a priority. If a company is having Management System issues then they should consider focusing on the items in Table 6 as a priority.

Once implemented the relevant performance data (PSPIs, audit and investigation findings) can be categorised into the cultural indicators and monitored to produce a sustainable continuous improvement process where performance data are regularly cross correlated with the findings of the last culture survey to identify which cultural area needs to be addressed as a current priority. The full flow chart for the process can be seen in Figure 6.

Over the next few years we expect to obtain further performance data from the companies we have been working with to further calibrate the causal links between PSPIs and cultural factors and report the findings in due course.

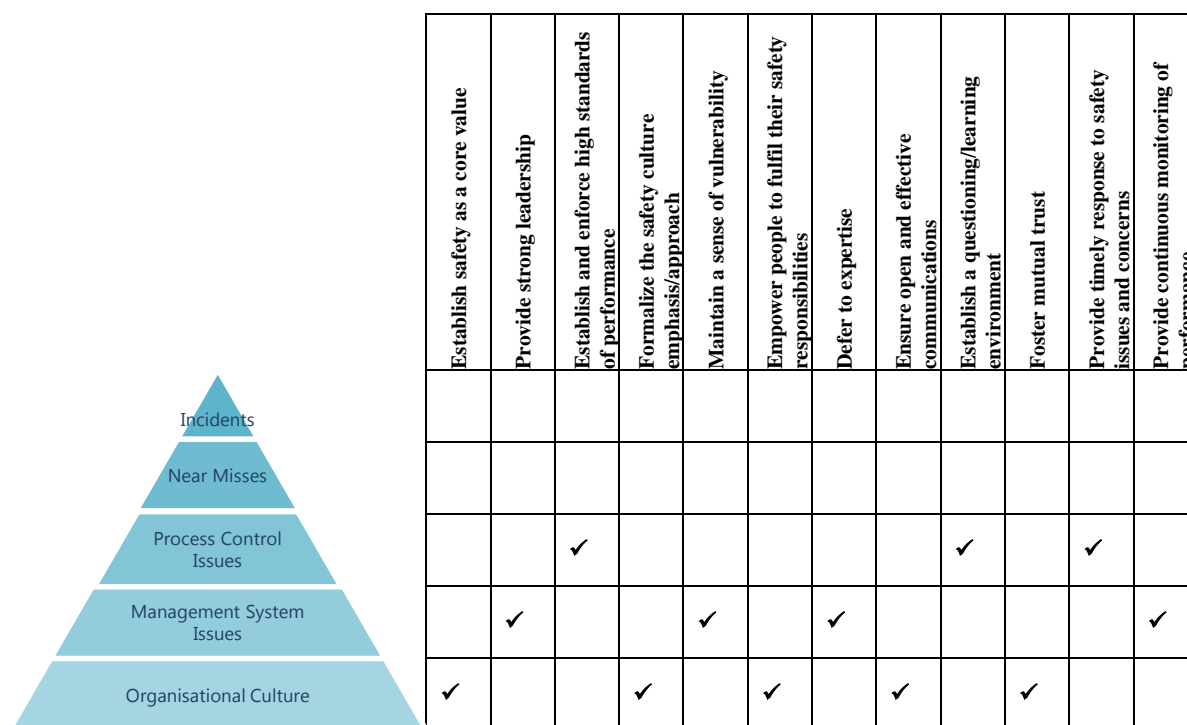


Figure 4 – Process Safety Triangle and Cultural Features

Table 5 – Cultural Priorities for Process Control issues

<i>Cultural Issue</i>	<i>Example Remedies</i>
Establish and enforce high standards of performance	<ul style="list-style-type: none"> - Communicate the performance expectations - Create a dialogue within the company on the importance of operational discipline - Promote accountability throughout the organization - Institute a constructive discipline policy - Promote a safe reporting environment - Create metrics and communicate results
Establish a Questioning/Learning Environment	<ul style="list-style-type: none"> - Add “What could have happened” to incident investigations - Conduct “what-if?” sessions with operating teams to discuss responses to operating problems and incident scenarios - Review key hazard scenarios with highest potential consequences with operating and technical teams - Distribute summaries of incident reports (company and external) that include what happened, lessons learned, and how the lessons might apply locally
Provide Timely Response to Safety Issues Concerns	<ul style="list-style-type: none"> - Provide a formal means for employee input of safety concerns - Develop a strong near miss identification system for potential process safety incidents - Determine roles and responsibilities and schedules for completion - Develop an improvement strategy and supply resources to reduce backlog; communicate progress to workforce - Develop a unified action item tracking system to stay on top of process safety items

Table 6 – Cultural Priorities for Management System Issues

<i>Cultural Issue</i>	<i>Example Remedies</i>
Provide Strong Leadership	<ul style="list-style-type: none"> - Establish a clearly defined process safety leader at a level - Process safety significance is reinforced throughout the chain of command - Address process safety issues in every company/work group meeting - Discuss process safety during day-to-day conversations - Visit workers and discuss process safety issues - Investigate lapses in process safety performance
Defer to Expertise	<ul style="list-style-type: none"> - Identify the technical experts for various functions and types of operating equipment - Define necessary technical disciplines that need to be involved in specific process safety activities (e.g., types of MOCs) and use them - Train the individuals identified as technical experts to fill their technology expertise weaknesses - Ensure SMEs are included in the decision making loop; seek out SME input - Develop a process safety training competency matrix for all levels of the organization
Maintain a sense of vulnerability	<ul style="list-style-type: none"> - Create institutional memory about past company accidents; communicate reminders - Investigate and communicate lessons learned from recent accidents throughout the company - Communicate lessons from external accidents - Provide hazard/risk awareness training to all new employees; provide regular refreshers - Adopt incident investigation policy to look at what could have happened instead of just what did happen
Provide continuous monitoring of performance	<ul style="list-style-type: none"> - Develop appropriate safety metrics scorecards and communicate broadly - Establish a process safety management review system - Include process safety topics in annual objectives for line management - Form a site-wide process safety committee from several disciplines to promote PS improvement - Ask senior leadership to promote process safety improvement in meetings

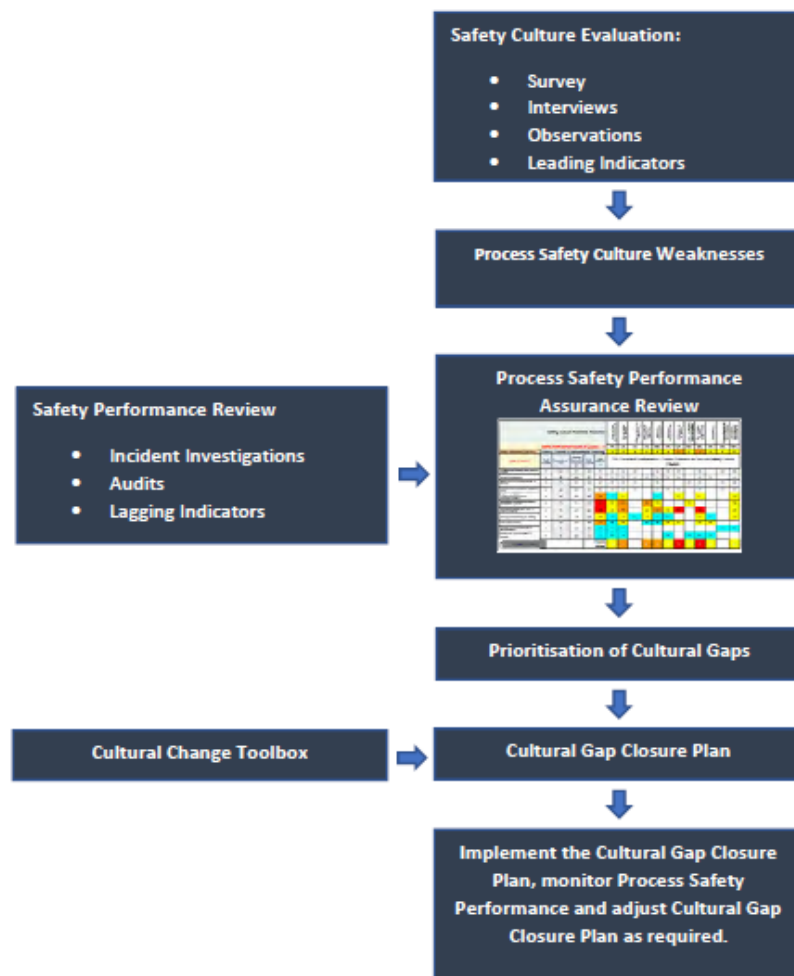


Figure 5 – Performance Assurance Flow Chart

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