Session No. 741

Avoiding Common PHA Mistakes

Glenn G. Young, C.S.P.—Owner
Glenn Young & Associates, LLC PSM Consulting
Baton Rouge, Louisiana

Introduction

The distribution of OSHA citations concerning CFR 1910.119 (Process Safety Management of Highly Hazardous Chemicals) is approximately as follows:

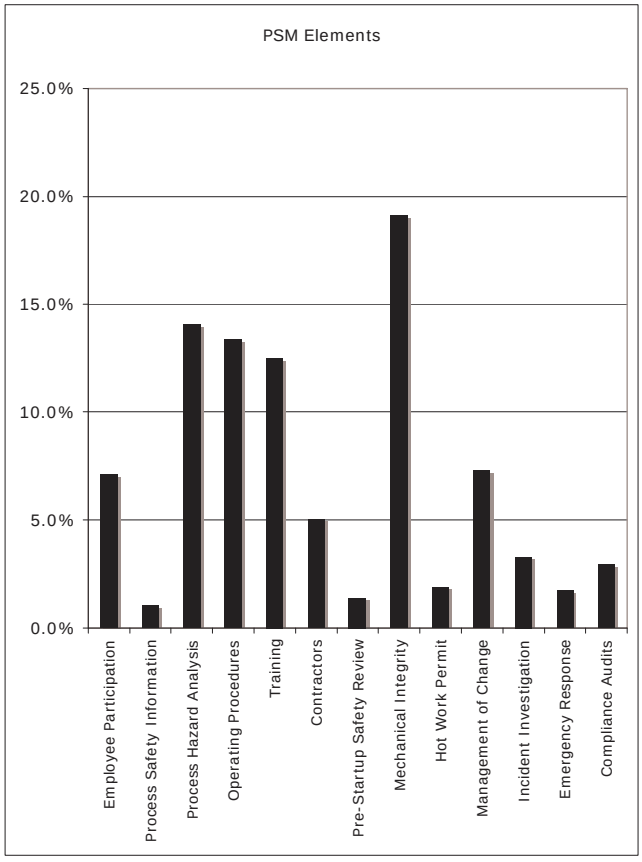

Exhibit 1. Table Data from 2000

The number of Process Hazard Analysis (PHA) citations is second only to the number of Mechanical Integrity citations. This paper discusses not only frequently cited PHA shortcomings but also those shortcomings noticed in PSM audits. For convenience, this discussion of shortcomings follows the chronological order of the PHA sequence.

Failure to revalidate or redo the PHA within five years

1910.119(e)(6) requires that PHA studies be redone or revalidated on five-year (maximum) intervals. The intention of the standard is that the entire study should be reviewed, not an incremental portion. Additionally, the report date of the previous PHA is the "start date" for timing of the five-year interval. To avoid citations, revalidate or redo the PHA in its entirety at least every five years.

Revalidating the same study more than once

Although this is not a requirement of OSHA, it is now recognized and generally accepted good engineering practice. Over the 15-year interval between three successive studies, it is very likely that internal PHA practices have changed, that regulatory requirements have changed, and that industry practices have changed. Revalidating the same original study again and again renders the PHA team unlikely to recognize and change the affected parts of the PHA. By making "every other PHA a full redo," the PHA facilitator and team are more likely to identify and correct shortcomings that would otherwise be missed.

Omitting documentation of the PHA team members' qualifications

1910.119(e)(4) requires that PHA teams consist of a minimum of one member with process knowledge of the equipment under review, one member with engineering expertise, and one trained facilitator. Unless the qualifications of these members are recorded in the PHA record, there may be no way in the future to verify that the necessary personnel were present for the team meetings. Always document not only the names but also the qualifications of PHA team members and keep this documentation in the PHA report.

Omitting a copy of the PHA procedure used

At the time that a PHA is performed, a specific PHA procedure is in effect. Subsequent PHA procedures are likely to include additional requirements that did not exist at the time of a previous PHA. Include the PHA procedure that was used by the team in the PHA report. With the procedure, any auditor can verify that the team followed the requirements that were in effect at the time of the PHA. Without a copy of the PHA procedure used by the team, the auditor may have to evaluate the PHA using the current (and newer) procedure. This would likely lead to citations of shortcomings for an older PHA.

Evaluating scenarios without a formal risk-ranking system

Many companies still attempt to assess risk without having formal severity, likelihood, and risk definitions. Without such metrics, including a "tolerable-risk matrix," there is no way to rank the relative risks associated with PHA scenarios. Without ranking relative risks, management has no way to prioritize the hazards identified by the PHA. In order to assure uniformity among the various sites within a company, a corporate guidance document that clearly defines severities, likelihoods, and tolerable/intolerable risks is essential.

Using inaccurate Piping & Instrument Diagrams

Some companies attempt to evaluate their equipment using out-of-date, overly-general, or grossly inaccurate Piping & Instrument Diagrams (P&IDs). If the PHA team is expected to update the P&IDs by walk-downs during the PHA, expect for the study to last significantly longer than if accurate drawings were available. Using the PHA team as a P&ID verification tool means that a team of employees (rather than a single one) is being used to field-verify the drawings. Depending on the size of the PHA team, this means that excessive cost is generated for what could have been done much less expensively prior to the study. PHA teams cannot produce a valid PHA without accurate drawings. Have P&IDs verified prior to PHA team meetings for the most cost-effective use of the PHA team's time.

Allowing "Black Boxes" on the P&IDs

When vendor-supplied package equipment is installed, the vendor-designed system is often added to the P&IDs as an empty box or "black box" marked "vendor supplied." In many cases, the local operating, instrument, or maintenance crew then modifies the equipment without documentation of what changes have been made. In some cases, equipment that has been in service (with field modification) for up to thirty years has been found still illustrated as a "black box" on the P&IDs. At some point, the owner must take responsibility for the package and develop their own (updated) P&IDs and instrument drawings for the equipment. Failure to do so can result in the PHA team missing obvious hazards.

Creating nodes that are too large

PHA facilitators, particularly those who are familiar with the equipment, sometimes create large nodes based on the function of a system. In some cases, entire distillation systems consisting of multiple distillation columns, exchangers, pumps, and controls are depicted as a single node. In such cases, there is no way that the PHA team can effectively identify all hazards of the process. The complexity and volume of equipment in the node make the common PHA guidewords overly vague. Only by subdividing large nodes into smaller, more manageable sections can adequate attention be given to the hazards of the process.

Omitting startup and shutdown conditions

Industrial incidents often occur during startup and shutdown situations. Unfortunately, many PHA studies fail to include startup/shutdown guidewords. Without consideration of how the equipment is to be cleared and brought to a safe state on shutdown, many hazards are overlooked. Without consideration of how the equipment is to be purged, recharged, and brought to normal operating conditions, many additional hazards are overlooked. Include a "Startup/Shutdown" guideword in the PHA as a reminder.

Omitting human error considerations from the PHA

Although human error often causes industrial accidents, many PHA studies do not capture the potential operator errors. Even in complicated, multi-step operations, PHA studies often omit consideration of out-of-sequence and omitted steps. Some PHA teams have even insisted that human error is not a credible possibility in their processes. Subsequent events have proven them tragically wrong. Always assume that human errors can occur.

Omitting evaluation of control failures

The consensus standard ISA-S84 (commonly known as "Safety Instrumented Systems") is now recognized and generally accepted good engineering practice. Despite this, many companies do not evaluate the consequences should trip systems fail to operate on demand. Control valves are considered under the "no flow" and "more flow" guidewords, assuming that the valves can stick or fail open or closed. However, trip valves, logic, and sensors are often overlooked in the PHA. This can lead to tragic consequences since trip systems are often more important to the safety of the process than control valves. Trip systems must be evaluated based on the risk created should the trip system fail to function on demand. This can be done during the PHA, or afterwards in a separate "critical-controls analysis."

Omitting evaluation of safety-critical manual block valves

The Chemical Safety Board has criticized companies who failed to identify, test for leak-through, and periodically replace their safety-critical manual block valves. The PHA team should evaluate the process, asking if any manual block valves exist whose leak-through might lead to PSM incidents. Should such valves be found in the process, a recommendation should be created to include the valves in a mechanical integrity program. The program should periodically test the valves for leak-through and/or replace the valves.

Omitting consideration of incidents from similar facilities

The Chemical Safety Board has criticized companies who have failed to use in-company experience from other sites with similar processes and from industry experience in similar

processes. Failure to learn from others' mistakes is a sure way to garner a citation. Do not ignore industry history.

Ignoring non-PSM incidents since the last PHA study

Often, incidents that should have been marked as PSM incidents or PSM near misses are not identified. Since these incidents are not marked as "PSM" in incident reports, the PHA team may overlook them. The PHA team should review all incidents since the prior PHA (not just the ones identified as PSM) to not only look for incident patterns but also to identify previously unrecognized PSM incidents/near misses. One sure indicator that PSM incident reporting has been substandard is the lack of PSM near misses. When near misses are not reported, it is likely that PSM incidents are under reported as well. Near misses should outnumber actual PSM incidents.

Omitting a human-factors and facility-siting checklist

CFR 1910.119(e)(3)(v-vi) requires consideration of human factors and facility-siting. While guidewords from the PHA can document some aspects of this requirement, they may be insufficient to meet full compliance. Adding a human factors/facility-siting checklist to the PHA documents that all aspects of these issues were considered.

Writing less than comprehensive recommendations

PHA teams often forget that their recommendations may have to be understood by others who are neither familiar with the process nor present when the recommendation was created. Recommendations must contain enough information so that the scenario of concern can be clearly understood, the recommendation can be clearly understood, and the equipment can be found both on the P&ID and in the field. To facilitate this, every recommendation should contain, at a minimum:

1. The full cause and consequence of the scenario of concern
2. The specific equipment numbers of lines, valves, pumps, vessels, etc. that are involved in the scenario of concern
3. Any special conditions needed to create the scenario of concern (shutdown, freezing temperatures, etc.)
4. What the team suggests be done to prevent or mitigate the scenario of concern
5. Why (if not immediately obvious) the recommendation that the team offers prevents or mitigates the scenario of concern
6. The drawing(s) where the equipment is found

Omitting documentation of the management review meeting

The management review team that reviews the PHA team's recommendations should have their work documented. That record should be kept with the PHA report. The documentation of the management review team meeting should include, at a minimum:

1. The date of the management review meting
2. Those present at the management review meeting (names & positions)
3. The disposition of each recommendation
4. The method by which each recommendation was approved or rejected

Allowing management excessive control over recommendations

The management review team should be provided with clear guidelines for accepting or rejecting recommendations. Typically, management is not allowed to reject a recommendation unless:

1. The recommendation is not required to protect safety, health, or the environment
2. The recommendation is not technically feasible (this does *not* mean "more expensive than we want")
3. The PHA team overlooked existing layers of protection that prevent or mitigate the scenario
4. LOPA or Event-Tree analysis demonstrate an already-tolerable risk
5. The PHA team was in error as to the cause-consequence scenario

If the management review team wishes to modify a recommendation, then the management review team should record in writing why their modified recommendation provides an equal or superior level of safety than the original recommendation.

Omitting additional risk analysis

PHA teams typically do a good job of estimating the severity of a scenario, but can do a variable job of estimating likelihood. It is human nature to assume that an event that has never happened is unlikely to happen and that an event that has occurred is likely to reoccur. Additional risk analysis methods such as Layers of Protection analysis, Event-Tree analysis, and Fault-Tree analysis are now considered recognized and generally accepted good engineering practice for all high-risk and high-severity events identified by the PHA team.

Failing to communicate the PHA results to affected employees

One of the most frequently cited shortcomings in the PHA process is the failure to communicate the PHA findings and recommendation results to affected employees and contractors. Even if such communication is done, failure to document the communication can still result in fines. When communicating the PHA results to employees (via e-mail, bulletin board postings, and/or safety-meeting verbal communications), always be sure to document when, to whom, and how the information was delivered, and save this documentation with the PHA report.

Failing to prioritize recommendations by risk

Recommendations pertaining to high-risk scenarios should be assigned earlier due dates than recommendations pertaining to lower-risk scenarios. Failure to prioritize recommendations by risk can result in citations.

Failing to complete recommendations in a timely manner

Another frequently cited shortcoming in the PHA process is the failure to close recommendations by completing the work and documenting the closure. Again, just having the work completed without any record of when it was completed leaves the company open to potential liability. PHA recommendations should be assigned due dates, based on their risk, and be documented to closure, with the date of completion recorded. These records are typically tracked in an electronic database. If the recommendation tracking is recorded on paper, the records should be stored with the PHA report.

Failing to create a "continuous improvement" plan for the PHA process

Audit findings typically include a focus on the PHA process itself and how the system can improve over time. By creating a formal improvement plan for the PHA process, the system can become self-correcting for errors and omissions and continuously improve the quality of the PHA process. Although not a regulatory requirement, having a continuous improvement plan shows management commitment to the PHA process.

Summary:

The PHA process is only as good as the procedure used. With a good procedure, there is far less chance of overlooking an important aspect of the PHA process. For consistency, use an identical procedure at multiple locations within the same company. As best practices are developed at one location, they can be easily migrated to other locations.

Internal facilitators should be encouraged to participate in PHAs at multiple sites within the company. This is another way to migrate best practices. Additionally, the more-frequent exposure to the PHA process will keep the facilitators PHA skills fresh.

Even the best PHA program can benefit from an outside perspective. Consider using independent consultants on occasion to bring new practices and methods to the PHA process. The consultants may be used either for PHA facilitation or to coach internal facilitators.

Facilitators who have extensive background in process operations, maintenance, and/or engineering often bring a wealth of experience to the PHA process that would otherwise be missed. Encourage the most experienced employees to become PHA facilitators.

With a strong procedure, experienced facilitators, and a knowledgeable PHA team, your Process Hazard Analyses should be beyond reproach.

Special thanks to numerous clients including:

- PotashCorp (PCS-Nitrogen, PCS-Phosphates)
- Georgia Gulf Corporation
- Pioneer Chlor-Alkalai
- Williams-Midstream Services

For sharing their best-practices.