HOW TO OSHA-PROOF YOUR PHAs

David A. Walker        Thomas R. Williams
Dale F. Nawrocki       William G. Bridges

JBF Associates, Inc.
1000 Technology Park Center
Knoxville, Tennessee 37932-3353
(615) 966-5232

The Occupational Safety and Health Administration’s (OSHA’s) new process safety management (PSM) regulation includes performance-based requirements that have managers and engineers speculating about what will be required of them, especially in terms of performing and documenting PHAs. This article discusses the basic features of a PHA approach, as well as features of individual PHAs that should increase the likelihood that these studies will withstand OSHA's scrutiny.

INTRODUCTION

In February 1992, the Occupational Safety and Health Administration (OSHA) issued its regulation entitled Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119), which became effective in May 1992. This performance-based regulation has managers and engineers wondering exactly what OSHA will find acceptable during subsequent PSM compliance audits, especially in the area of performing and documenting process hazard analyses (PHAs). Paragraph (e) of the regulation addresses the primary requirements for performing and documenting PHAs. These requirements include (1) prioritizing and scheduling initial PHAs, (2) choosing appropriate hazard evaluation techniques to use in an analysis, (3) addressing specific topics in a PHA, (4) selecting an analysis team, (5) documenting and communicating the team's findings and recommendations as well as the company's resolution of them, (6) updating and revalidating PHAs, and (7) retaining PHA records.

This article describes strategies for planning, performing, and documenting PHAs to help improve the chances that your PHAs will stand up under OSHA's close examination. The guidance suggested in the article is based on our extensive experience in working with companies in the chemical and hydrocarbon processing industries through our company, JBF Associates, Inc. (JBFA). JBFA is a consulting firm that specializes in process safety management, hazard evaluation, reliability engineering, and quantitative risk assessment. This article presents many of the insights our company has gained through participation in the development of OSHA's PSM regulation and our involvement in PHAs at numerous facilities.
WHAT IS COMPLIANCE?

Unlike most of OSHA’s regulations that prescribe specific equipment requirements or actions to be taken, the PSM regulation is performance-based. OSHA and industry have established the goals of the regulation, the basic elements of a program designed to fulfill these goals, and outlines of important activities associated with each element. However, OSHA does not define the specific methods and approaches that companies must implement (e.g., OSHA does not define which hazard evaluation technique must be used for a specific type of process). Although the performance-based nature of the regulation allows companies flexibility in defining specific approaches that best meet their own needs and organizational structures, the lack of precise, clearly defined minimal requirements leaves managers and engineers speculating about what will actually be required to achieve compliance.

OSHA intends to base its compliance judgments on facility inspections. These inspections may be part of routine inspections, or they may be specially initiated because of employee complaints or a catastrophic incident. OSHA personnel will base their inspections on OSHA's Instruction CPL-2-2.45A, which is the compliance directive for the PSM regulation. The directive is the primary guidance for OSHA safety and health inspectors, and includes the following activities relating to PHAs:

· Audits of documentation associated with (1) the overall PHA approach at a facility (e.g., prioritized schedules for completing initial PHAs of covered processes) and (2) the results of specific PHA studies (e.g., the resolutions of recommendations from selected PHAs). These audits review the trail of documentation verifying that formal PHA activities exist and have the appropriate parts, that PHAs are being implemented according to the procedures defined by the company, that specific PHA studies are being conducted in an appropriate and thorough manner, and that results of PHAs are being acted upon in a timely fashion.

· Interviews with employees who participate in PHA activities, and with employees whose jobs are affected by the implementation of PHA recommendations. These interviews help ensure that employees are involved in the process of conducting PHAs and resolving PHA recommendations, that employees believe PHAs are being conducted in an appropriate manner, that employees believe no important hazards have been overlooked, and that PHA results have been communicated to affected employees.

· Inspections of process equipment. These inspections are intended to help ensure that PHAs have effectively addressed the obvious hazards of the process and that no significant equipment deficiencies exist. Key areas of interest in these inspections may include hydrocarbon or toxic gas monitors and alarms, impact protection for piping, pressure relief devices, flares and other destruction systems, electrical classifications, and control room siting issues.
To be OSHA-proof, PHAs must convincingly fulfill the goals and specific requirements in paragraph (e) of the PSM regulation. Three factors primarily affect the likelihood that PHA activities can withstand OSHA’s sharpest attention:

- Explicitly addressing each PHA issue described in the PSM regulation. Clearly, PHA activities should cover every PHA issue in the regulation (including specific requirements such as completion deadlines). Conversations with OSHA officials indicate that a PHA should document how the requirements of the PHA were met.

- Applying technical expertise to appropriately fulfill the goals of each PHA activity. Not only must PHAs address the items mentioned in the regulation, PHAs should be technically thorough. Technical thoroughness is judged against recommended practices and approaches from other regulations, professional organizations, consensus standards, and industry practices. For example, a hazard evaluation technique should be performed according to the recommended guidelines for that technique.

- Establishing credibility for the PHAs. Addressing the required features for PHAs and having technically thorough PHAs will help establish credibility for the individual PHAs and the overall PHA approach. However, unless the PHA activities create auditable documentation, even a very competently performed PHA could suffer criticism. Therefore, key PHA activities (e.g., documentation of PHA results and communication of PHA results to employees) deserve special attention to help ensure that auditors readily recognize the quality of the PHA efforts.

The following sections describe detailed strategies for developing and implementing PHAs that (1) reduce the likelihood of catastrophic incidents occurring at your facility and (2) increase the likelihood that your PHAs can withstand OSHA’s scrutiny.

**PARAGRAPH (e)(1): PRIORITIZING AND SCHEDULING PHAs**

The first step in prioritizing a PHA program is determining which processes are covered by the OSHA PSM regulation. The OSHA regulation requires that PHAs be performed for all processes involving (1) highly hazardous chemicals at or above threshold quantities (specified in Appendix A of the regulation) or (2) quantities of flammable liquids and gases onsite in one location in excess of 5 tons. This regulation excludes hydrocarbon fuels that are not part of a processing unit, as well as flammable liquids stored in atmospheric tanks or transferred (without chilling) below their boiling point. The issue of covered processes is continually evolving (with almost weekly clarifications from OSHA), but this article will focus on conducting PHAs under the assumption that a process is covered by the regulation.

The PSM regulation mandates that PHAs be completed as soon as possible, but at least in compliance with a 5-year phase-in schedule. PHAs must be performed in priority order, with the rationale for the priority documented by the employer. The rationale must include consideration of the process hazards, the number of potentially affected employees, the age of the process, and the operating history for the
process. Some companies have gone so far as to develop quantitative approaches with various inputs to prioritize processes for evaluation. This level of detail is probably not necessary and may be counterproductive because this type of ranking scheme takes substantial effort to develop, document, and defend. A more straightforward qualitative prioritization based on the judgments of knowledgeable individuals who are familiar with the processes should be adequate. Involving employees familiar with the process operations in the prioritization process is strongly recommended.

OSHA is suggesting a common-sense approach for addressing the highest-risk processes first at individual facilities. For example, a process that has experienced numerous incidents over the past few years would probably merit higher priority than one that has operated safely for 20 years. Likewise, a small unit having a low inventory of hazardous chemicals and few operators would probably merit a lower priority than a major unit having a large inventory of hazardous chemicals. The goal is to establish priorities that will address the units with the highest risks first, and to have a defendable basis for determining the priorities. The key to having a defendable basis is to document the rationale used in determining the priorities.

Once the priorities are established, a schedule for performing PHAs must be developed. OSHA requires 25% of the initial PHAs be completed by May 1994, 50% by May 1995, 75% by May 1996, and 100% by May 1997. A schedule must therefore not exceed this timetable. However, OSHA also requires that the initial PHAs be performed "as soon as possible." The schedule should reflect a reasonable effort to perform the PHAs quickly. For example, it would be difficult to defend a schedule that calls for completion of 50% of the PHAs in 1993, then shows no further activity until 1995. Likewise, a facility with only one or two covered processes will find it extremely difficult to defend a prolonged schedule (e.g., taking 5 years to perform an analysis of a water treatment system if there are no other covered processes at a facility). The schedule should be documented and revised as necessary to reflect the best estimate of when the PHAs will be completed.

Keep in mind that the regulation targets individual facilities rather than entire companies and corporations. Therefore, the prioritization of processes should be made in relation to other processes at the same facility. The schedule deadlines from the regulation also apply to an individual facility (not to the entire corporation).

Although very large processing operations may be divided into distinct operating units for analysis, OSHA has indicated that large interconnected processes should not be artificially divided (i.e., "gerrymandered") into subsections so that the smaller studies can be scheduled over a longer period of time. PHA teams should divide large units on technically defendable bases. This might include divisions because (1) adequate distance and isolation exist between parts of a large unit or (2) operating responsibilities are clearly divided between parts of a large unit. For example, a large organic-chemical plant could be divided into the major distinct processing units at the facility such as the feed material processing units, intermediate product units, and storage and handling units. However, dividing an
intermediate product unit into smaller sections with separate analyses for each section might be more
difficult to defend. Regardless of how you decide to divide your system for analysis, be sure to document
the criteria used to guide the decisions as well as how the criteria were applied in making the decisions.

PARAGRAPH (e)(2): CHOOSING APPROPRIATE HAZARD EVALUATION TECHNIQUES

Hazard Evaluation Techniques

The first step in performing a PHA is choosing appropriate hazard evaluation techniques, as specified
in paragraph (e)(2) of the PSM regulation. The methods approved by OSHA include (but are not limited
to) What-If Analysis, Checklist Analysis, What-If/Checklist Analysis, Hazard and Operability (HAZOP)
Analysis, Failure Modes and Effects Analysis (FMEA), and Fault Tree Analysis. The following
paragraphs provide brief summaries of these techniques. For more detailed descriptions of these and
other hazard evaluation methods, refer to Guidelines for Hazard Evaluation Procedures, Second Edition
with Worked Examples, authored by JBF Associates, Inc. and published by the Center for Chemical
Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE), 1992 (Reference 1).
This book is the primary PHA reference cited in Appendix D of OSHA's PSM regulation.

What-If Analysis. The What-If Analysis technique is a systematic method for examining the responses of
process systems to equipment failures, human errors, and abnormal process conditions. This technique
requires participation by team members who know and understand the basic hazards associated with the
process and its operation. The team leader helps a team develop "what-if" questions about the process
(e.g., "What if the pressure regulator failed to close?"). By answering these questions, the team identifies
potential hazards and suggests ways to improve safety.

The results of a What-If Analysis are generally documented by listing the specific questions,
responses, and recommendations generated in the meetings. One of the strengths of this method is that it
can be applied to any system at any stage of its design or development. However, the results of the
analysis are highly dependent upon the experience of the leader and the team, and the completeness of the
list of questions. Because it is not as systematic as other techniques, What-If Analysis is not generally used
as a stand-alone PHA technique. However, What-If Analysis is an excellent supplement to more
structured techniques such as HAZOP, FMEA, and Checklist Analyses.

Checklist Analysis. Checklists are commonly used for identifying known types of hazards associated with
a process and for helping ensure compliance with standard industry practices. This technique compares
aspects of a system against a list of items to discover and document possible deficiencies. The items
included in a checklist should be based on features of similar systems, on company standards, and on
common industry practice/experience. The quality of a Checklist Analysis is highly dependent upon the
relevance of the checklist items and how well the person completing the checklist understands the items.
Therefore, the analysis should be conducted by a team of personnel with industry experience, knowledge
of similar processes, and understanding of the particular system being analyzed. Checklist Analysis is an
experience-based technique that strengthens any PHA effort; however, Checklist Analysis alone does not generate the brainstorming of potential process problems that more creative hazard evaluation techniques such as What-If, HAZOP, and FMEA offer. A checklist review of one specific piece of equipment for which an appropriate checklist exists (e.g., a safety checklist that was developed by experts for evaluating new compressor installations) may be adequate; however, conducting a PHA using only a checklist is not generally recommended.

What-If/Checklist Analysis. The What-If/Checklist Analysis technique, an improvement over the two individual methods discussed above, combines the brainstorming of What-If Analysis with the systematic nature of Checklist Analysis. The checklists used in these analyses usually include more general items intended to inspire creative thinking about known types of hazards and potential incidents. Because such checklists are inherently based on experience, and because applicable checklist items may differ from site to site, a team may choose to "What-If" potential events that are beyond the experience base of a checklist. For instance, docking, mooring, and unloading of barges involves specific procedures that, although common throughout the industry, can include subtle differences for each facility. A checklist of marine-related items could be used to analyze common docking equipment and procedures, but What-If Analysis might be needed to identify hazards specific to the subject facility. What-If Analysis also uses the team members' individual creativity and experience to allow extensive brainstorming of general issues introduced by the checklist.

HAZOP Analysis. The Hazards and Operability (HAZOP) Analysis technique provides an efficient, detailed, and auditable study of process variables. HAZOP Analysis systematically identifies ways the process equipment can malfunction or be improperly operated, leading to undesirable conditions. To apply the HAZOP Analysis technique, the team analyzes each process section (vessels, pumps, interconnecting piping, etc.) or procedural step to identify consequences of deviations from the design or procedural intention. For each deviation, the team (1) decides whether any consequences of interest would result from credible causes of the deviation, (2) identifies the engineering and administrative control features that guard against the deviation, and (3) recommends ways to reduce the likelihood of the deviations or severity of the consequences. Results of a HAZOP Analysis are usually recorded in a table listing item numbers, descriptions of the deviations, possible causes identified by the team, potential consequences of the deviations, existing safeguards (control features), and recommendations of the team.

Because it is thorough and easy to use, HAZOP Analysis is the most popular technique for PHAs. In fact, many people still refer to PHAs as "HAZOPs," although OSHA's requirements for PHAs exceed the features generally associated with a classic HAZOP Analysis alone. In general, supplementary techniques such as small-scale What-If and Checklist Analyses help ensure coverage of special requirements for OSHA compliance.

Failure Mode and Effects Analysis. The failure mode and effects analysis (FMEA) technique involves the methodical study of component failures. All failure modes for each component in a system are identified,
and the effect of each component failure on the system is evaluated. As in the HAZOP Analysis technique, existing safeguards are identified, and recommendations for further improvements are documented. Because the FMEA technique focuses on component failures, process chemistry problems (e.g., autocatalytic decomposition) may be overlooked. For this reason, the FMEA technique is most appropriately used in the chemical and hydrocarbon processing industries for processes that do not involve reactive chemistry (e.g., crushing, blending, mixing, conveying, transferring, distilling, coating, or packaging). Complex control systems, such as emergency shutdown or interlock systems, are also often analyzed with the FMEA technique.

Fault Tree Analysis. Fault Tree Analysis is a deductive reasoning method for determining the logical relationships of component failures and human errors that result in a specific failure of a system. The fault tree portrays the combination of failure events that cause a specific undesired system failure, commonly referred to as the TOP event. This technique can be used to quantify the frequency or likelihood of a system failure; however, quantification is often not required to identify the most important contributors to system failures. This technique is generally too detailed and too specific for frequent use in PHAs. It is best used when the PHA team needs to evaluate system failures that result from multiple equipment failures and/or multiple human errors.

The documentation of a Fault Tree Analysis usually includes the graphical fault tree model, the combinations of failures that cause the TOP event, and numerical evaluations of the TOP event. This technique is most often used to complement a HAZOP, FMEA, or What-If/Checklist Analysis (e.g., to model specific system failures, such as a furnace explosion).

Which Technique to Choose?

Rarely is there a single best hazard evaluation technique for a PHA. In fact, the selection often involves choosing not one technique alone, but rather several complementary techniques for analyzing different parts of a process or different types of hazards associated with a process. When selecting hazard evaluation techniques, you must consider the severity of the hazards of the process (i.e., the inherent hazards of the chemicals and the process conditions), the complexity of the process (e.g., the nature of the control systems), and the efficiency of the techniques for addressing the hazards of the process. Most often, a detailed, well-structured hazard evaluation technique such as HAZOP Analysis or FMEA is used as the basic technique for the PHA of a process. In sections of the process where the hazards are less severe or the process is less complex, a less detailed (but more efficient) technique such as What-If/Checklist Analysis is used. Conversely, sections of the process with more severe hazards or more complex control logic may warrant the use of a more detailed technique such as Fault Tree Analysis. Additionally, analyses using specific checklists are almost always useful for supplementing the other hazard evaluation techniques by addressing special concerns such as facility siting issues, human factors issues, or critical equipment design issues (e.g., fired heater control safeguards). The key is to select techniques that (1) best meet the needs of the analysis and (2) complement each other to produce an efficient study that does not overwork the problem. For more details on choosing techniques, see Chapter
5 of the *HEP Guidelines* (Reference 1) and the article "Process Risk Evaluation — What Method to Use?" (Reference 2).

**PARAGRAPH (e)(3): ADDRESSING SPECIFIC PHA TOPICS**

Regardless of the analysis technique chosen, the PHA must address the required issues listed in the regulation (such as human factors, previous incidents, and facility siting). The key to establishing credibility for individual PHAs is to describe in the PHA report how the PHA team addressed each of these issues. Most importantly, missing any piece of the PHA puzzle could have severe consequences.

**Hazards of the Process.** The team should evaluate process hazards based on the nature of the chemicals involved (toxicity, flammability, etc.), the process conditions (flow, temperature, pressure, composition), the team’s experience, and information about previous incidents in the facility (and at other sites). Material safety data sheets (MSDSs) and similar information can be helpful in understanding the potential effects specific process materials have on personnel; however MSDSs alone do not always identify all of the pertinent hazards (e.g., properties of potential contaminants). For the purposes of the OSHA PSM regulation, the hazards of concern are those that could lead to toxic material releases, fires, or explosions that could result in catastrophic consequences within the facility (i.e., worker fatalities or serious injuries).

**Previous Incidents.** A discussion of previous incidents is a valuable part of any hazard evaluation. One way to do this is to collect relevant incident reports filed within the past 5 years (or since the most recent PHA) and review them as a team during the course of the analysis. Because many companies have not maintained thorough incident records in the past (especially for near-misses), this type of information will be more difficult to obtain for the initial PHAs. In the absence of thorough incident reports, the PHA team may find that employee injury reports, environmental release reports, and interviews of employees with extensive knowledge of the process's history help identify many of the potentially catastrophic incidents and near-misses at the facility. (Be aware that these reports often contain additional information that will not be particularly useful during a PHA, such as reports on employee slips, trips, and falls.)

The team should evaluate the results of the incident investigations, as well as the initially suggested remedies, and make recommendations for further improvements (if necessary). Reviewing incident information will help focus the analysis on known problems and help reduce the potential for recurrence. This exercise may also uncover weaknesses in the existing incident reporting and investigation system. For example, a PHA team may identify that an instrumentation change made for one vessel as a result of a near-miss should also be made to a similar vessel in the process.

One way to give credibility to discussions of previous incidents is to create a table summarizing the previous incidents and any suggestions the team develops pertaining to the previous incidents. Alternatively, copies of incident reports could be included with the PHA report as an appendix, or the PHA report could refer readers to the location where the incident reports are filed.
Engineering and Administrative Controls. The PHA team should address the engineering and administrative controls applicable to the hazards of the process. These controls may include detection devices that provide early warnings of releases, inventory reduction policies, fire protection systems, criteria for equipment spacing, pressure relief devices, and process instrumentation and interlocks. All the hazard evaluation methods described above (including What-If and Checklist), if used creatively, can include consideration of engineered and administrative controls (often referred to as existing safeguards) and how they play a role in detecting and mitigating releases of hazardous materials.

Consequences of Failure of Controls. An analysis team should document the reasonable worst-case consequences for a particular deviation, component failure, human error, etc., without taking credit for existing safeguards. This approach is analogous to examining the consequences associated with failure of engineering and administrative controls. Once the consequences are documented, the team should focus on identifying existing safeguards that protect against the deviation. The more severe the consequences, the more the team should focus on the need for specific, reliable safeguards (both engineering and administrative control features).

To add credibility to the PHA team's efforts, a well-documented PHA should describe the types of events that may result in catastrophic consequences, the specific causes and consequences of those events, the safeguards that are in place to protect against those events, and any recommendations suggested by the team. This information should be documented for not only those events for which the team made recommendations, but also for the other events for which the team believed existing safeguards were adequate. This information helps establish credibility for the study in several ways: (1) describing all of the events that the team reviewed demonstrates the technical thoroughness of the review, (2) documenting the potential events for which no additional safeguards were suggested helps defend the PHA team's rationale for not suggesting additional protections, and (3) documenting potential events for which additional safeguards were suggested helps explain the PHA team's bases for suggesting the additional protections. On the other hand, more documentation of the PHA team's discussions can provide more opportunities for second-guessing the team's opinions (especially if an incident occurs). However, being able to completely explain the PHA team's approach, considerations, and rationale is more defensible than having no record of what the team considered (or even that the team considered a particular issue at all).

Facility Siting. Facility siting reviews (1) identify hazards caused by the proximity of process equipment containing hazardous materials to other equipment, buildings, and personnel locations and (2) recommend ways to reduce the hazards. Facility siting can be addressed in a number of ways during a PHA. The team can estimate (qualitatively) consequences associated with an event based on the location of the process equipment with respect to the control rooms, other population centers (e.g., maintenance shops, engineering offices, administration buildings), and other process equipment (e.g., motors that could provide ignition sources). Valuable resources for facility siting reviews include design specifications for control rooms, separation distances for key areas from the process equipment, locations of drains and
fresh air intakes, proximity to fire protection equipment, and the location of potential ignition sources for flammable materials. If a team includes current, experienced operators and engineers (as required by the regulation), the team will be very familiar with the layout of the subject process. This knowledge can be supplemented with plot plans and tours of the facility for team members unfamiliar with the physical layout. Individual team members should take additional tours of the facility to answer specific questions (posed during the team meetings) regarding distances between equipment, location of controls and mitigation systems (and if these might be damaged or inaccessible in a catastrophe), labeling, area lighting, etc. A What-If/Checklist Analysis can be used to ensure thorough coverage of facility siting issues and to document that these issues were covered during the PHA.

Human Factors. Human errors are known to be the most significant contributors to major process accidents. For this reason, OSHA has highlighted the importance of considering potential human errors during PHAs. Team members should consider human factors throughout the course of a PHA. Potential human errors should be considered as causes of process upsets during the analysis. The team should estimate whether operators would have adequate time, information, and equipment to respond to deviations (i.e., to contribute to incident prevention and mitigation). Although not specifically required in the PSM regulation, formally reviewing routine operating procedures and other nonroutine procedures (e.g., startup, shutdown, and maintenance procedures) by means of a hazard evaluation is an excellent way to uncover error-likely situations that could result in catastrophic consequences. In fact, reviewing these procedures is the best way to help identify hazards during off-normal operating modes. In their enforcement actions after major process accidents, OSHA has repeatedly required companies to perform hazard evaluation studies that focus on operating procedures. Deciding to review these procedures may exceed the minimal requirements for complying with the current PSM regulation, but these reviews can help OSHA-proof your PHAs from future enforcement actions while significantly reducing the likelihood of process accidents related to human errors. One of the best hazard evaluation approaches for reviewing procedures is a modified form of the HAZOP technique. This approach and several other approaches are discussed in "Strategies for Integrating Human Reliability Analysis into Process Hazard Evaluations" (Reference 3) and A Manager's Guide to Reducing Human Errors (Reference 4).

Checklists can be used to evaluate human factors engineering considerations to ensure coverage of issues such as accessibility, labeling, workloads, the use of automatic versus manual controls, simplicity of instrument and control displays, and the clarity of signs and alarms. In addition, a team leader can use prepared questionnaires to solicit input from operators, supervisors, and managers regarding perceived facility hazards. The results of these interviews should then be reviewed with the rest of the team.

A well-documented HAZOP table will include human factors in the discussion of causes and safeguards related to process deviations. Similarly, including a copy of what-if questions or checklist items will help to show that your PHA team performed a thorough analysis of human factors.
Range of Effects on Employees. An analysis team should document consequences of interest in terms of potential releases, fires, and explosions, realizing that employees could suffer a range of health effects if such accidents occurred. The documented consequences should include reasonable worst-case effects assuming the safeguards fail. To assure coverage of a range of effects, the team should also document any consequences that are less severe than the worst-case effects, but still of interest (e.g., consequences that would have potentially adverse effects on employees). For example, even if the ultimate consequence of high pressure in a vessel (assuming the safeguards fail) could be a large release of hazardous material from a rupture, the team should also document the less severe consequence of relieving hazardous material through a relief device. The team should then consider whether the vessel is adequately protected against high pressure and whether the relief device discharges to a safe location. This examination of a range of consequences of interest for a given deviation provides a more complete analysis than one that focuses only on worst-case events.

PARAGRAPH (e)(4): SELECTING A QUALIFIED TEAM

The PSM regulation requires that the PHA be performed by a team with expertise in engineering and process operations. The team must include at least one employee who has experience and knowledge specific to the process being evaluated (especially the day-to-day operations of the process) and one person who is knowledgeable in the specific process hazard analysis methodology being used. OSHA has indicated that PHAs conducted by a single individual (even if that person satisfies the criteria above) are likely to miss important hazards. OSHA believes that involving multiple people in the PHA process (even for techniques such as Fault Tree Analysis and FMEA, which are often performed by single individuals) reduces the likelihood that important hazards will be overlooked. For this reason, PHA teams must be composed of more than one person, but not so many that the size of the team becomes unmanageable (typically no more than six to eight people involved in a single PHA session).

Personnel responsible for designing and operating the specific process possess the bulk of the knowledge and experience needed for a detailed hazard evaluation. Thus, the team should include a process and/or design engineer who is knowledgeable about the process/facility design and a senior operator or supervisor who has significant experience in operating the various processes to be reviewed. Other personnel familiar with the maintenance, instrumentation, and inspection and testing of equipment in the process/facility should be part of the team or "on call" to answer specific questions during the course of the review.

Whether an in-house employee, corporate specialist, or outside consultant, the PHA methodology specialist should have experience in using the hazard evaluation tool(s) chosen for the PHA. Ideally, the PHA leader should also have a breadth of experience in the various PHA techniques. This allows the leader to choose appropriate techniques for each aspect of a study, thus ensuring the quality of the study without overworking the problem and wasting valuable resources.
Listing the team members and their job titles or functions in the PHA report will help verify compliance with the team composition requirement of the regulation.

PARAGRAPH (e)(5): MANAGING THE RESULTS OF PHAs

A critical element of a PHA program is the resolution of team findings and recommendations. Whether it is a one-page letter or a formal policy manual, there should be a written description of the system for addressing team recommendations.

The resolution system should ensure that the recommendations are resolved in a timely manner, that the management response to each recommendation is documented, and that any actions to be taken are completed as soon as possible. A written schedule for completion of any actions should also be developed, and documentation of completion should be included in the resolution files. Also, it is important to document the rationale for the completion schedule, particularly for any actions that may not appear to an OSHA inspector to be scheduled "as soon as possible." Having all of this documentation readily available will lend a great deal of credibility to the thoroughness of the PHA recommendation resolution program.

Communication of PHA results to affected employees is an area that could be easily overlooked in a PHA management system, but it is probably as important as complete documentation for developing an OSHA-proof PHA. OSHA plans to use both interviews of employees and reviews of PHA documentation to verify compliance, and it is crucial that both sources of information agree. Therefore, be sure to familiarize all PHA team members with (1) the goals of the PHA program, (2) the methodologies used in the study, (3) how the study addressed each of the requirements of the PSM regulation, and (4) how the team's findings and recommendations were resolved. What could be more damaging to the credibility of a PHA than to have team members tell an OSHA inspector that facility siting or human factors weren't covered (when in fact the employees just didn't understand what the study did), or that they had no idea what became of the team's recommendations?

It is also important that all employees affected by actions resulting from PHA team recommendations be informed of the actions and trained appropriately. For example, if an emergency isolation valve is added to a line, the operators need to know when and how to use the valve.

PARAGRAPH (e)(6): DEVELOP A PLAN FOR UPDATING AND REVALIDATING PHAS

OSHA requires that PHAs be updated and revalidated at least every 5 years. Although not an immediate issue in establishing the credibility of critical PHAs, a well-defined updating plan can help a company allocate its PHA resources most efficiently over the life of a process. Facilities having well-documented PHAs and good documentation from other PSM programs, such as management of change and incident investigation, will reap benefits in this area. Updating and revalidating can be accomplished on a routine schedule or may be initiated due to significant changes in the process or process operations.
(e.g., prior to the pre-startup safety review for a significantly modified process). Depending upon the differences between the process at the time the PHA was performed and the process at the time of updating or revalidating, a PHA leader may choose to simply modify the existing PHA or to completely redo the PHA, using the previous PHA as a guide to expedite the process. Processes that have had few incidents, few changes in equipment, and few changes in operating procedures are the best candidates for simple modifications to the existing PHA. If many incidents have been occurring, or if many changes have been made to the process, redoing the PHA is likely to be more efficient and more prudent. Regardless of the updating or revalidating approach, all of the issues previously discussed in this paper (with the obvious exception of deadlines for completing initial PHAs) apply to updated and revalidated PHAs.

PARAGRAPH (e)(7): RETAINING RECORDS OF PHAs

The records of all PHAs, including updates and revalidations, as well as the documented resolutions of PHA recommendations, must be retained for the life of the process. The information must be stored in a manner that allows retrieval within a reasonable period of time and provides access to the information for all employees (as required by the employee participation requirements of the PSM regulation). The retention system must ensure that permanent records are safely stored for future reference. Electronic media storage is not prohibited.

INTERFACES WITH OTHER PSM PROGRAMS

Every element of a PSM program for a facility is closely related to the other PSM elements. This interdependence of elements is an important consideration in OSHA-proofing your PHAs. PHAs are based on the information created from other PSM elements (process safety information, operating procedures, management of change records, mechanical integrity documentation, etc.). If there are deficiencies in PSM activities that support PHA activities, the PHAs could be deficient, even if the PHA approach is consistent with the requirements in paragraph (e) of the PSM regulation. OSHA recognizes the interdependence of PSM elements (especially process safety information and PHAs). For example, conducting a PHA without having adequate process safety information available would not satisfy the regulation. OSHA intends to specifically review the interactions of individual PSM elements during inspections. Therefore, when OSHA-proofing your PHAs, you must ensure that the information intended to support PHA activities will meet OSHA’s expectations. Compliance audits of directly related PSM elements should help identify weaknesses that could adversely affect PHAs.

CONCLUSION

There are many pieces to the PHA puzzle, and each piece requires planning and execution to produce an OSHA-proof PHA. The PSM regulation is a performance-based standard. To be confident that your PHA will be deemed acceptable, you must not only do everything that OSHA expects, but you must also be able to show how you comply with the requirements. Table 1 summarizes some of the questions you need to answer to help you perform a PHA that can withstand OSHA’s scrutiny.
For some organizations (e.g., those with little experience in performing hazard evaluations or those with severely limited resources), simply meeting the basic PHA requirements of OSHA's PSM regulation will be a significant endeavor. Other organizations (e.g., those with more hazard evaluation experience, those with more advanced internal policies, or those with more resources) may choose to not only fulfill their obligations with regard to the regulation, but also to exceed the minimal requirements in an effort to achieve the following goals:

- Bolster their compliance with regard to the OSHA regulation (especially in gray areas where minimal requirements are difficult to define or where minor modifications to the regulations or enforcement policies could make their PHAs deficient).
- Achieve goals involved with other industry PSM initiatives (e.g., the Chemical Manufacturers Association's Process Safety Code of Management Practices).
- Reduce the likelihood of having to redo studies to gain compliance with future regulations. In anticipation of similar PHA requirements as part of risk management plans (which will be mandated and enforced by the Environmental Protection Agency [EPA] as part of their public safety charter under the Clean Air Act Amendments), a prudent PHA team may want to expand the scope of the study to include hazards posed to the public and to the environment.
- Improve their overall safety performance (especially at facilities with hazardous materials or hazardous processes that are not covered by the regulation or at facilities where safety performance has been weak). This might include performing more frequent PHAs and conducting more detailed studies than required by the current regulations.
- Gain economic and operational benefits (e.g., identifying and reducing process upsets and system failures that result in product quality degradation, equipment damage, business interruption, and expenses associated with process accidents) to offset the resource allocations needed to perform PHAs.

As PHA efforts increase, the confidence of withstanding OSHA's scrutiny increases, and the costs of the PHA efforts increase. However, because of the factors described above, prudently expanding PHA efforts in some areas can yield many benefits that begin to offset the costs of the PHA efforts. In fact, in many facilities, PHAs can actually produce a net profit for companies while satisfying regulatory requirements and significantly improving safety at a facility. Several of our clients have identified such important operability improvements while conducting PHAs that the expected performance improvements will more than pay for the studies.

A company's approach to performing PHAs is highly dependent upon its perceptions of the hazards involved in its operations, its available resources, its management goals, and its corporate philosophy. While developing and implementing a PHA approach, managers and engineers should bear in mind that their decisions today will likely affect the outcome of a critical test in the future (e.g., an OSHA audit or a legal action as a result of an incident).
Table 1  How OSHA-Proof Are You?

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you prioritized PHAs for all of your covered processes? How is your prioritization rationale documented?</td>
</tr>
<tr>
<td>Have you scheduled your PHAs to be completed &quot;as soon as possible&quot;? Does your schedule meet at least the minimum completion requirements?</td>
</tr>
<tr>
<td>Do you have an appropriate basis for selecting a hazard evaluation technique for a PHA? How is that basis documented?</td>
</tr>
<tr>
<td>Have you identified and documented the hazards of the process to be analyzed? Have you evaluated and documented the range of health effects of these hazards to employees?</td>
</tr>
<tr>
<td>Have you reviewed previous incidents, both documented and undocumented, for contributions to process hazards? How are the results of this review documented?</td>
</tr>
<tr>
<td>Have you identified and reviewed the existing engineered and administrative controls applicable to the process? How is this review documented?</td>
</tr>
<tr>
<td>Have you addressed the consequences of failure of these controls? Have you documented the safeguards identified for all events that could result in a hazardous event (regardless of whether analysis of an event led to a specific team recommendation)? How have you documented this?</td>
</tr>
<tr>
<td>Have you reviewed hazards related to the relative location of equipment within a process, as well as the relative location of that process to other processes? How is the review documented?</td>
</tr>
<tr>
<td>Have you evaluated the contribution of human errors to process hazards? Is the review documented? Have you reviewed operating procedures?</td>
</tr>
<tr>
<td>Have you selected a qualified team to perform the analysis? How are the qualifications of each team member documented?</td>
</tr>
<tr>
<td>Do you have a written program for addressing recommendations arising from a PHA? Does your program ensure that recommendations are resolved quickly, that actions taken are completed &quot;as soon as possible,&quot; and that the resolution of the recommendations is completely documented?</td>
</tr>
<tr>
<td>For existing studies, have you resolved all recommendations in a reasonably timely manner?</td>
</tr>
<tr>
<td>Do your employees know how your PHA program works? Are they made aware of any actions resulting from a PHA that might affect them?</td>
</tr>
<tr>
<td>Do you have a means to store all the documentation of your PHAs for the life of the process?</td>
</tr>
<tr>
<td>Are your other PSM programs related to PHAs (particularly process safety information and operating procedures) adequate to support PHAs? Was the process safety information used for the PHA accurate?</td>
</tr>
</tbody>
</table>
REFERENCES


