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# The Impact of Quality on The Effectiveness of Process Hazard Analysis

An ioMosaic White Paper

## Introduction

Despite investment of considerable resources to conduct process hazard analyses (PHAs), many companies are still experiencing a high rate of incidents and find that the causes of these incidents have not been identified and/or addressed in their PHAs. The main reason that PHAs are not effective is that adequate attention has not been paid to the quality of the PHA.

Under the OHSA Process Safety Management (29 CFR 1910.119) Standard there are specific items that a PHA must address, including prerequisites (process safety information), scope, methodology, team composition and qualifications, documentation, communication and follow-up, and revalidation. Although these requirements help to assure some level of completeness and quality in the PHA, there is still considerable room for bias and inexperience to limit the quality of the final product. Quality issues in these areas are having a serious impact on the effectiveness of PHAs.

## Process Safety Information

Inadequate process safety information is the leading cause of PHA quality issues. Some of the more critical information that is typically missing or incomplete is:

- Relief device sizing basis
- Equipment safe limits
- Material reactivity, corrosivity and incompatibility data
- Control and interlock set points and actions
- P&IDs

Since PSI is constantly being updated through the Management of Change program, it is important to include copies or version numbers of the actual PSI used in a PHA. Without accurate information the PHA team will make assumptions about how the system is designed and may not take into account serious design deficiencies. For example, there is a relief valve on a reactor vessel, but the sizing basis is missing, so the assumption is that it is adequate. However, there may be two-phase flow conditions or reacting products during a relief event. These conditions may not have been considered in the relief system design.

The correct approach to missing or incomplete PSI is to make a recommendation to find or develop the missing information. Never take credit for PSI that is missing or incomplete.

## Scope

Inadequate definition of the scope of the PHA can lead to critical equipment being left out. It is important to consider upstream and downstream equipment as well as any interfaces. Common issues here are the quality control procedures and process control information for the distribution systems for raw materials and utilities used in the covered process. For example, steam used in a process is reduced to 15 psig for use in a 50 psig rated vessel. Upstream of the pressure-reducing valve, the steam header relief is set at 150 psig. Therefore, the process vessel needs to have pressure relief in case the pressure-reducing valve fails open and introduces 150-psig steam directly to the vessel. Another common issue under scope is proper definition of the hazards of concern. Too often, PHAs focus on the big events like fires, explosions and toxic releases, but other hazards such as asphyxiation or rotating equipment cause more injuries than the big events.

## Methodology

Selection of PHA methodology is critical. The Hazard and Operability (HAZOP) methodology is the most widely used, but is often criticized for being too resource intensive. Unfortunately, any systematic approach like HAZOP requires adequate time to complete. There is a perception that the What-If methodology is faster, but our experience is that in order to do the same thorough analysis, both methodologies require about the same amount of time to do a quality job.

There are also pitfalls in implementing specific methodologies. For example, selecting study sections that are too small can limit the hazards that the team identifies because they may not recognize the consequences of deviations outside the study section. On the other hand, selecting a study section too large may also cause the team to miss hazards because a deviation may apply to more than one piece of equipment. For future revalidations, it is critical to highlight all the equipment, piping and instrumentation that is included in a specific study section by highlighting on the P&ID.

Another issue is how the consequences of a scenario are developed and the number of failures that need to occur to produce consequences of concern. The team must look beyond the initiating event for a scenario and consider all contributing events. For example, deadheading a pump would produce a no flow scenario and the consequences for the process would need to be evaluated. However, a deadhead condition would eventually lead to pump seal damage and loss of containment. Here the contributing event is that the deadhead condition goes undetected for sufficient time to cause a catastrophic seal failure. When listing instruments as safeguards, it is critical to future revalidations to include the specific tag numbers, particularly if the instruments are outside the study section or on a different P&ID.

## Staffing

An effective PHA leader must be an expert in the methodology used. Formal training for all internal PHA leaders companywide is important to ensure the quality of PHAs from site to site. In addition, the PHA leader should have solid process experience in either design or operations. A PHA leader that has experience in conducting PHAs at other facilities and for other companies will be able to identify more potential hazards. Often, PHA leaders are merely facilitators and rely solely on the team members to identify hazards. The team leader must be able to question the design of the system and not assume something cannot happen because it hasn't happened in this process or that the process control system will always prevent it from happening. Equally important is that the team leader be unbiased. As for the rest of the PHA team, it is important to have adequate representation by individuals who understand how the process is designed, how it operates and how it is maintained. Team composition is critical to ensuring that the process is evaluated according to its design intent. For example, having an operator from the process present during the PHA is critical, but if the area under review is the reaction step and the operator attending is responsible for truck unloading operations, adequate details on how the reactor is operated may not be considered.

## Reporting

All of the effort expended in updating PSI and applying the methodology can be lost if the recommendations are ineffective. The first pitfall is making too many recommendations. A PHA team can always recommend ways to further reduce risk, but the real issue is whether the risk is tolerable without additional mitigation. Here is where an effective risk matrix can help in determining which scenarios pose a high risk that needs to be mitigated. In this fashion, limited resources can be targeted to those high-risk scenarios and not wasted on scenarios that already pose low risk. Use or misuse of a risk matrix for determining the risk of PHA scenarios is covered in another ioMosaic Corporation white paper, "Designing an Effective Risk Matrix".

The next pitfall is recommending administrative controls where engineering controls can be implemented. Engineering controls in general are considered to be more effective than administrative controls. Too often project managers will opt for administrative controls in order to avoid project overruns. Next, all recommendations must mitigate risk for a specific scenario to a tolerable level. This needs to be confirmed using a risk matrix or other means. If not, additional recommendations will be needed. Another common issue is taking credit in the current scenario for recommendations made in a previous scenario. Until a recommendation is implemented, it should not be listed as a safeguard. Finally, the intent of the recommendation must be clear so that when it is implemented, the risk is reduced to a tolerable level. For example, the PHA team made a recommendation to consider implementing an interlock on a reactor. Using the word "consider" in a recommendation implies that the PHA team is uncertain as to its importance and leaves the door

open for the recommendation to be rejected. The key is to have a risk matrix or other means to determine if a recommendation is necessary to mitigate risk. What action is most effective to mitigate the risk can be finalized after the PHA is completed.

## Follow-up

An effective follow-up system needs to be developed to ensure that each recommendation is addressed in a timely manner. Proper documentation must be maintained to support any recommendations that are rejected or modified. There also needs to be verification that each recommendation was implemented as described in the PHA worksheets or action plan. Too often recommendations are either not implemented or not implemented as intended by the PHA team. For example, it is common practice to list a recommendation as complete because a work order was written, without verification that the work order was ever completed.

A PHA requires considerable resources to implement and if done properly and with adequate control of the key quality issues discussed above can be an effective means to reduce the risk of processes and prevent accidents.

## Quotes

*"Inadequate process safety information is the leading cause of PHA quality issues."*

*"Inadequate definition of the scope of the PHA can lead to critical equipment being left out."*

*"A PHA leader that has experience in conducting PHAs at other facilities and for other companies will be able to identify more potential hazards."*

*"An effective risk matrix can help in determining which scenarios pose a high risk that needs to be mitigated."*

*"An effective follow-up system needs to be developed to ensure that each recommendation is implemented in a timely manner."*

## Additional Resources

1. Frederick T. Dyke; 2002
2. Henry Ozog; 2002