Building Competency in Internal PHA/HAZOP Leaders - lessons learned in 40 years of doing so

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Abstract

Process safety is a deep topic and requires the involvement of nearly ALL staff at a site. But, how do you make sure your staff are up to the task? And how do you judge the competency of subcontractors or third party experts? This paper describes the basics of building competencies in one of the process safety activities that require expert levels of competency: PHA/HAZOP LEADERSHIP. The paper shows how many companies, beginning with Olin Chemicals and others in the 1970s through hundreds of companies today have planned for the progression to full competency of PHA/HAZOP Leaders and Scribes. The paper describes step by step what is required for each level of competency. One focus of the paper is that competency cannot be measured by exams and case studies (at least not completely); competency must instead be judged through hands-on observation, by those who are already expert in PHA Leadership.

Background

The increasingly complex and technical demands of process safety management (PSM) have placed a large demand on existing resources across the process industries. Success requires the utilization, involvement, and full support of nearly ALL staff at an operating site. Success also demands that a substantial portion of staff be competent and capable of contributing in a PHA.

Unfortunately, the process safety competencies required for people to become qualified are not easy to achieve quickly. New engineering graduates may have academic exposure to safety engineering principles and critical thinking skills, but they generally lack specific training on process safety fundamentals, though that is changing in many engineering curricula. More importantly, new graduates lack the practical experience

required to make sound risk management judgments and they lack the skill required for many tasks in PSM, such as leading process hazard analyses (PHAs).

Other papers[1] have covered the broader topic of achieving competency in all process safety elements and skills. This paper focuses only on the attainment of competency in Process Hazard Analysis (PHA) / HAZOP leadership and scribing.

Developing and Maintaining Organizational Competency

As illustrated in Figure 1, an organization gains competency through the identification and development of the requisite **Skills**, but skills alone are not sufficient. Organizational competency also requires that **Information** is developed and shared, that a learning **Culture** (supportive, nurturing, and encouraging) is maintained to ensure that the skills are developed and applied in an effective manner, and that **Performance Measures** are monitored to continuously evaluate performance and reevaluate organizational needs.

Figure 1: The Make-Up of Competency for an Organization
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The follow steps illustrate how organizational competency can be achieved.

Step 1: Identifying Competency Needs

Understanding the organization's process safety skill requirements is the first building block of developing competency across the organization. What are the organization's needs in process safety?

A gap analysis is essential to develop these skill requirements. Begin by identifying the organization's current strengths and weaknesses in process safety. What is going well and should be maintained? What improvements are necessary and how will those be achieved? Then, establish organizational goals and objectives for maintaining and improving process safety performance.

Once process safety goals and objectives have been established, it is possible to identify what skills, individual competency levels, and resources are needed to successfully meet those objectives. Comparing the available inventory of resources with the organization's needs identifies those gaps which must be filled.

An inventory of competencies can and should be developed for each aspect of process safety engineering[1] (as discussed in earlier papers):

- Relief valve sizing
- Safety instrumented systems
- Corrosion engineering
- Selecting the right materials of construction
- Fire protection
- Etc.

and each activity/skill within process safety management

- Incident investigation
- PHA leadership
- Auditing
- Procedure Writing
- Etc.

Just as the organization needs specific skills such as PHA Leadership and relief valve sizing, the leadership also needs to have knowledge. Selected leadership may also need to advance to in skill, reaching advanced and expert levels, as shown in Figure 1.

Step 2: Identify Candidates

After the organization has identified the inventory of process safety skills and resources needed, it must now determine how those needs will be met. Some organizations may decide to develop a relationship with external service providers for much of the process safety engineering expertise required and even for some of the process safety skills. Others may decide to develop this expertise internally, relying on external support only until internal resources can be developed (it is hoped that this is the approach all companies adopt). There are many factors outside the scope of this paper that must weigh into this decision for each organization. Regardless, it is important to maintain a healthy mix of internal participation to ensure ownership and consideration of specific process technology issues and external engagement to ensure continuous learning and best practices are used.

If internal resources will be used, then it is important to identify good candidates early in the process for further development as advanced and expert level resources. Awareness training provide ideal opportunities to begin this process.

For formal training, ensure all sessions include interactive workshops and other small group activities designed to apply the skills being taught. Have the instructors observe and evaluate participants based on their interest level, their natural ability to grasp and apply the skill, and their interaction with others as participant and leader. Ideal candidates will quickly grasp the technical aspects of a skill, learn to apply them in an appropriate way, serve as a positive role model for others, gravitate to leadership roles within the group, and gently begin to encourage, coach, and teach others who may not grasp the concepts as quickly.

At this stage, it is important to keep an open mind about the possibilities that lie within each individual. At the risk of reinforcing stereotypes, engineers sometimes bring technical knowledge and critical thinking skills, but sometimes lack the communication skills and personal empathy needed to become a good teacher. Operators may bring the practical knowledge and credibility necessary to be a good facilitator, but sometimes lack the detail orientation and education necessary to conduct a thorough analysis. People bring a wide variety of education, experience, abilities, and biases to the table. The organization's competency development job is to build on their strengths and fill their gaps.

Step 3: Culture - Develop Career Paths and Opportunities

Incorporate the process safety skills inventory and competency requirements (such as Figure 4 shown later for PHA/HAZOP Leadership) into the normal career progression for all roles. When considering individuals for advancement or promotion, give consideration to the development and demonstration of process safety competencies appropriate to the role. For example, incident investigation, management of change, and operating procedures are important within the operations ranks. Management of change, mechanical integrity, and writing of maintenance procedures are important for the progression of mechanics. Process technology and hazard evaluation are important for the progression of process engineers. In each discipline, establish the minimum competencies required to progress to the next level. Reward those who exceed the minimum requirements with additional learning opportunities, special projects, coaching assignments, individual recognition, and promotions. With higher levels of progression, should come higher compensation as well.

It is often desirable to develop a formal career path for engineers which includes advancement and demonstration of process safety competency. For example, competence levels can be described for the skill "Pressure Relief Device Adequacy Assurance." which is one of elements of "Process Safety Risk Assessment." A complementary skill of "relief valve design" is necessary for "process safety engineering."

Example: A process engineer has shown aptitude and expressed interest in advancement in process safety. Work with this engineer's manager to build a developmental plan that incorporates process safety competency developmental goals. Identify learning opportunities such as an advanced class in inherently safe process considerations, participation in or leadership of a process hazard analysis, an opportunity to lead a complex incident investigation, or a mentoring assignment to coach and develop others in leading human factor audits.

Step 4 – Build individual competency (expanded on later in this paper)

Individuals build competency through their natural abilities, education, training, and experience. Formal training classes provide the basic awareness and knowledge necessary, but advanced skills require application and hands-on experience in real-world applications. As illustrated in Figure 2, the skills learned in a classroom setting must be locked in with practice with a mentor (expert). Practice without a mentor who is expert in PHAHAZOP leadership will not build the skills necessary for a good leader, because there are many lessons that cannot be taught in a classroom setting:

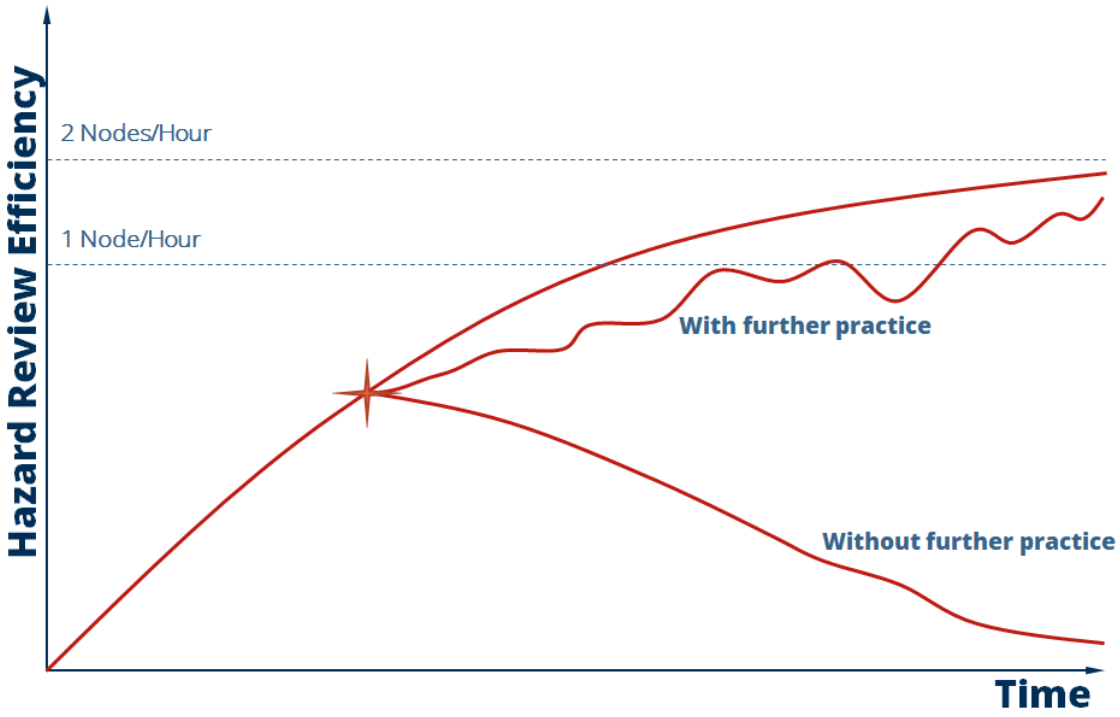

Figure 2: Value of Practicing with a Mentor/Expert in PHA/HAZOP Leadership
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Mentors who have already demonstrated advanced skills should be assigned to each new learner to provide guidance, feedback, encouragement, and support. This assignment is

important to the mentor as well since more real expertise is developed by coaching and teaching others. Experts (the most expert of the mentors) gain and enhance their competence by acting as stewards over the discipline, developing standards and guidance documents, overseeing coaches and trainers, and interacting with other experts outside the organization to continuously learn, improve, and create new knowledge.

Some organizations reward Experts at the same compensation level as vice presidents of the company because they recognize the potential vulnerability and loss of investment in losing Experts.

Step 5 – Maintain Proficiency and Extend Skills

Organizations maintain and extend process safety competency by providing a supportive culture, making information available, and evaluating performance.

A supportive process safety culture begins with management's understanding, commitment, and unwavering support of process safety management as a critical risk management tool. Resources are made available, priorities are clearly established, and key performance indicators are monitored and discussed to ensure that process safety related activities are completed. A supportive process safety culture also values and recognizes its expertise. Process safety stewards are visible, engaged, and available. Such support is especially key to the specific expertise of PHA/HAZOP leadership.

Step 6 - Measure and evaluate results, reevaluate needs

A strong set of leading and lagging metrics is essential to measuring and monitoring performance. Such metrics should be established for all elements. For PHA/HAZOP Leadership, the metrics would include using experts to evaluate the quality, thoroughness, and efficiency of PHAs.

Developing, Measuring, and Maintaining Individual Competency

Competency is the knowledge, experience, and skill to do something well enough to meet a standard. An individual gains competency through the combination of natural abilities, general education, experience, and specific skill/task training (classroom and hands-on), as should in Figure 3.

Figure 3: The Make-Up of Competency in an Individual
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Some of these components, such as education or experience (knowledge), can be measured directly and minimum standards established. However, evaluation of the competency level requires demonstration of the ability and judgment by others who are already competent. How can someone who is NOT an expert judge the competency of someone in a new skill or activity?

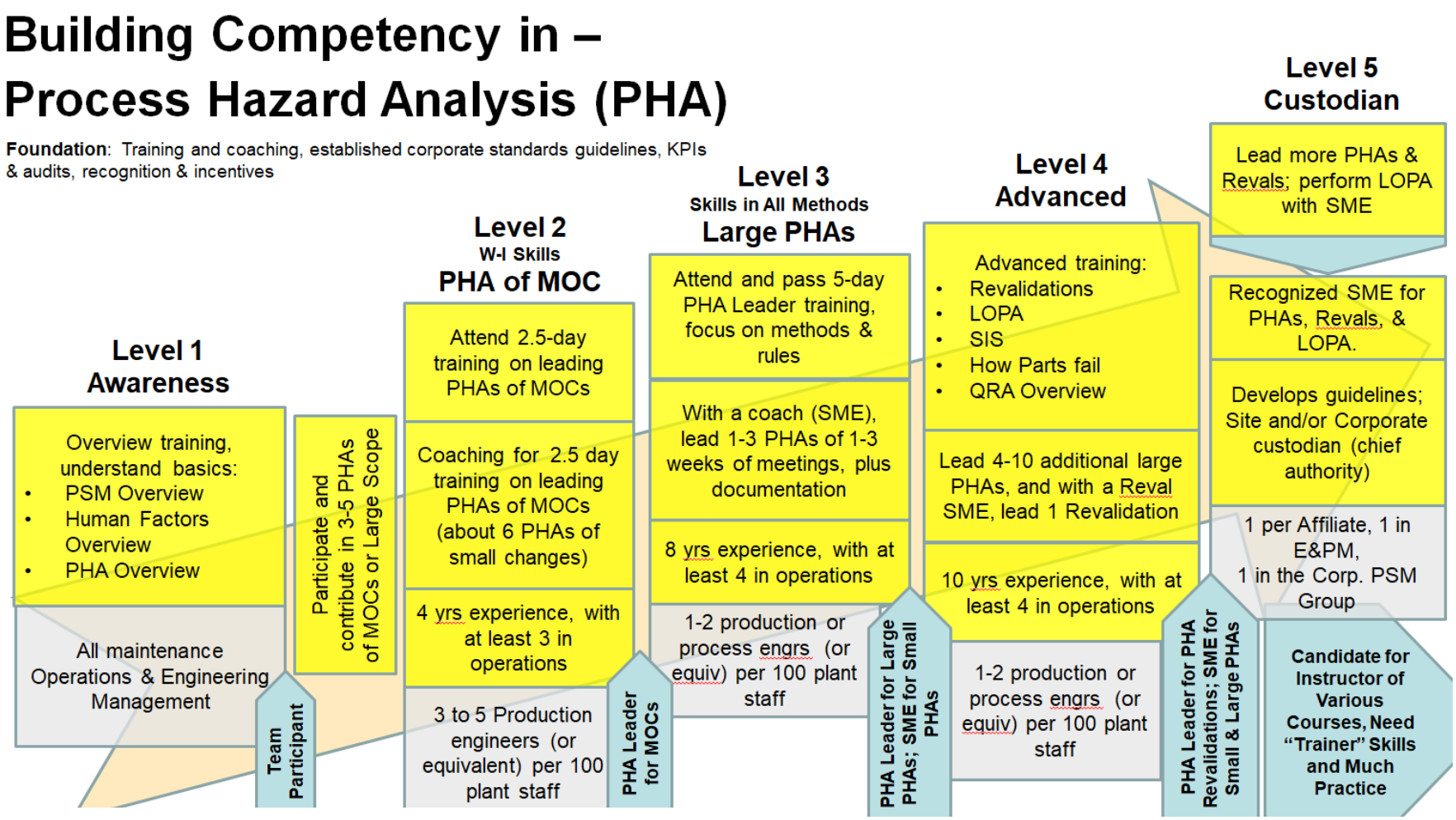
Progressive competency levels are reached over time by participation in specific activities and achievement of specific milestones. Increasing levels of expertise are mastered and maintained through training and mentoring by experts, stewardship of organizational guidelines and standards, and external engagement with others. Figure 4 shows how this progression applies to building competency in PHA/HAZOP Leadership.

PHA/HAZOP LEADERSHIP - Specific Steps to Competency

Figure 4 on the next page provides an overview of the entire competency progression process for PHA/HAZOP Leadership.

> *Note: If your organization does not currently have staff that have completed such a program, then you must take care when contracting PHA leaders and scribes, and 90% or more appear to be unqualified to this standard. One approach is to implementing a vetting procedure that includes an interview, a brief test on a moderate complex scenario, such as a gas blow-by scenario, and observation during the first week of a PHA onsite.*

Figure 4



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Based on training more than 5,000 PHA leaders, the best steps to build PHA competency in an organization's internal staff are:

- Establish a clear, gap-free standard for what makes an excellent PHA scope.
- Make sure the initial PHA Leaders and Scribe training covers this scope.
- Establish the minimum educational and experience requirements for PHA leaders (see **Appendix 1** of this paper for the requirements established within PII).
- Establish incentives for motivated engineers to want to be PHA leaders and scribes and to want to move up the expertise ladder (management in the company need to support these incentives, of course).
- Select candidates for leaders and PHAs for small MOCs; all candidates should have completed pre-requisites of experience and core knowledge training (see Appendix 1 for descriptions of these course modules).
    - *MODULE 1a. PSM Overview, 1-day – training completed*
    - *Module 1b. Human Factors Overview, 1-day – training completed*
    - *Module 1c. PHA Overview, 1-day - training completed*
    - *Minimum of 4 years' experience*
    - *At least 2 years in operations or production engineering* role
- Provide classroom training for candidates (score the candidates in classroom training; choose top graduates for earliest coaching sessions)
    - *MODULE 2. PHA Leader Training for Small Changes (MOCs), 2 days (see Appendix 1 for an outline of this course)*
- Instructor evaluates potential of each attendee based on understanding and application of course material. Table 1 illustrate a typical scoring of course graduates.

Process Hazard Analysis Leadership - 5-day training by PII								**Revised:**	11-Dec-14
	Instructors:	Greg Smith & Adel Dakheel							
	Course Date:	12/7 - 12/11, 2014		**Hadeed**		Observations and General Rating by Instructor on Participant's Understanding of:			Other comments
#	NAME	ID	Division	Department	Exam	Technical Knowledge	Leading	Scribing	
1	[redacted]		SPDR	DR ABC	96	Good	Okay	Good	Okay as team member
2			SPDR	DR-DE	96	Good	Okay	Good	Okay as team member
3			SPDR	SP FP	100	Good	Okay	Okay	Okay as team member
4			SPDR	SPOS	96	Excellent	Very Good	Very Good	Very good grasp of concepts
5			MSD	SPOS	88	Good	Good	Good	Okay as team member
6			MSD	ELECTRICAL	96	Good	Good	Good	Good grasp of concepts
7			MSD	Utilities Dept.	92	Good	Good	Good	Good grasp of concepts
8			MSD	Utilities Dept.	96	Excellent	Very Good	Very Good	Very good grasp of concepts
9			MSD	W/S	96	Good	Good	Good	Okay as team member
10			MSD	Utilities Dept.	100	Excellent	Very Good	Very Good	Very good grasp of concepts
11			RM	CMC	88	Excellent	Excellent	Excellent	Strong leader potential
12			RM	CMC	100	Very Good	Good	Good	Good grasp of concepts
13			RM	LP II	92	Very Good	Good	Good	Good grasp of concepts
14			RM	ROLL SHOP	96	Excellent	Very Good	Very Good	Very good grasp of concepts
15			RM	L&D	96	Very Good	Good	Good	Good grasp of concepts
16			RM	L&D	100	Excellent	Excellent	Excellent	Strong leader potential
17			ISD	SAFETY	92	Very Good	Good	Good	Good grasp of concepts
18			RM	L&D	100	Very Good	Good	Good	Good grasp of concepts
19			DR	ED	86	Good	Okay	Okay	Okay as team member

Table 1: Typical scoring system for graduates of 5-day PHA Leadership class

- For the top graduates, Subject Matter Experts (SMEs) provide coaching for 2-3 days during PHA of 4 to 8 MOCs, with actual PHA team members

- Graduates complete 6 more MOC PHAs without coaching
- SME reviews all work and certifies competency of PHA leader for MOCs (or not). If candidate passes these rounds, certify the leaders for small (MOC) PHAs, and add to internal affiliate list of Certified MOC PHA Leaders (they can lead now PHAs of MOCs on own, with appropriate team members)
- Candidates (including graduates PHA Leaders for MOCs) attain at least 7 years' experience overall, with at least 5 years in operations or production engineering role.
    - *MODULE 3. Leadership and Scribe Training for Major PHAs, 5 days (very heavy of workshops and learning skills; see Appendix 1 for an outline of this course)*
- Instructor evaluates potential of each attendee based on understanding and application of course material
- For the top scored candidates, SME provides coaching for 1 to 3 weeks of PHA meetings and for 1-2 weeks of after meeting effort, during actual PHAs with actual team members
- Eventually, candidate completes 2-3 more weeks of PHAs without coaching
- SME evaluates meeting skills and documentation of reports. If candidate passes these rounds, certify the leaders and/or scribes for full (major) PHAs, and add to company-wide list of Certified PHA Leaders and Scribes (they can lead and/or scribe large PHAs)
- Get opportunities for them to lead PHAs somewhere within company, such as during capital projects or ReDos.
- Candidates attain at least 8 years' experience overall, with at least 5 years in operations or production engineering role.
- Candidate complete
    - *MODULE 4a. Leadership and Scribe Training for PHA Revalidations, 2 days (see Appendix 1 for an outline of this course module)*
    - *MODULE 4b. LOPA, 2 days*
    - *MODULE 4c. How Components Fail, 1 day*
    - *MODULE 4d. SIS, 2 days*
- SME for Revals provides coaching for 1 weeks of PHA meetings and for about 1 weeks of pre-meeting and after-meeting effort combined, during actual PHA Reval(s) with actual team members
- Eventually, candidate completes 1 PHA Reval without coaching
- SME for Reval judges meeting skills and documentation of reports. If candidate passes these rounds, certify the leader and/or scribe for PHA Revals, and add to SABIC-wide list of Certified PHA Reval Leaders (they can lead PHAs Revals)
- Certified PHA Reval Leaders advance (or not) to SME Level with enough practice and consensus of two SMEs
- Any Certified Leader can serve as co-instructor in Module 1c, 2, 3.
- Any Certified PHA Reval Leader can as co-instructor for Module 4a
- Candidate advances to Instructor Level (or not; very few will have all of the personality traits, delivery skills, and mentor-level expertise for this level). PII to judge this level.

Companies should use SMEs from outside (such as PII staff) until they build the appropriate expertise within their own organization.

Content and Goal of each Training Module and Follow-on Coaching

Training Module 1a. PSM Overview, 1-day. *See PII Course 1*

PII recommends a maximum of 25 students with one instructor.

Training Module 1b. Human Factors Overview, 1-day. *Streamlined version of PII Course 10*

PII recommends a maximum of 25 students with one instructor.

Training Module 1 c. PHA Overview, 1-day. *See PII Course 8-O*

Includes PHA Meeting Video for team membership training and includes lifecycle of PHAs within PAE.

PII recommends a maximum of 25 students with one instructor.

NOTE: All company technical staff should attend Modules 1a, 1 b, 1c. as part of general PSM competency core courses.

Training Module 2; PHA Leader Training for Small Changes (MOCs), 2 days. *Streamline version of PII Course 8 (see Appendix 1 for an outline of this course module)*

- ***The GOAL should be to achieve competency (after follow-on coaching) as a Team Leader for Small PHAs of Changes Only (MOCs).*** *Selected graduates progress to PHA leadership training for full (large) PHAs.*
- Review PHA team membership requirements
- Review team meeting rules
- Refresher on Human Factors and tie directly to PHAs of small changes (MOCs) in this module
- PHA Documentation Requirements for Small Changes (MOC)
- Brief Coverage of PHA Documentation Requirement for Major PHAs (projects, Redo PHAs)
- Review PHA methodologies of What-If, HAZOP, and Checklist
- Several student led, intensive workshops on using mainly the What-if methodology for the hazard ID and risk assessment of mainly Small Changes (MOCS):
    - Continuous mode of operation
    - Batch operation (loading and unloading)

    - Start-up, shutdown, and other transient modes of operation
- Focus on the graduate's role facilitating PHAs of small changes and ensuring the documentation is recorded efficiently and accurately.
- *Maybe include "How to use LEADER software" in this module (about 2 hours at end of week), but we suggest doing this training in Module 3 instead, since MOC PHA leaders rarely use LEADER for their documentation; though it can help*
- Reiterate the incentives the company has for attaining higher levels of competency in these topics.

For this module, PII recommends a maximum of 15 students with one instructor and a maximum of 25 students when a co-instructor is added.

Training Module 3. Leading and Scribing Large PHAs; duration 5 days *(see Appendix 1 for an outline of this course module)*

- ***The GOAL (after follow-on coaching) should be to achieve competency as a Team Leader and/or Scribe for Large PHAs.*** Focus on the graduate's role facilitating large PHAs and ensuring the documentation is recorded efficiently and accurately
- Review PHA team membership requirements
- Review team meeting rules
- Refresher on Human Factors and tie directly to PHAs in this module
- Life cycle of PHAs, including when to do which PHAs during *Major Capital Projects*
- PHA Documentation Requirement for Major PHAs (projects, Redo PHAs)
- *Regulatory Requirements (in regions where applicable)*
- Review PHA methodologies of What-If, HAZOP, and Checklist
- Many student led, intensive workshops on leading PHAs using the various methods for the hazard ID and risk assessment of:
    - Continuous mode of operation
    - Batch operation (loading and unloading)
    - Start-up, shutdown, and other transient modes of operation
- Introduce FMEA (Failure Modes and Effects Analysis)
- Choosing the right methods based on hazard and complexity, using simple chart from PII
- *How to use LEADER™ software (about 2 hours at end of week)*
- Reiterate the incentives the company has for attaining higher levels of competency in these topics.

For this module, PII recommends a maximum of 15 students with one instructor and a maximum of 25 students when a co-instructor is added.

Training Module 4a. Leading PHA Revalidations, 2 days. *See PII Course 9*

For this module, PII recommends a maximum of 15 students with one instructor and a maximum of 25 students when a co-instructor is added.

Training Module 4b. LOPA, 2 days. *See PII Course 11*

For this module, PII recommends a maximum of 20 students with one instructor.

Training Module 4c. How Components Fail, 1 day. *Extracted from PII MI, Course 6*

For this module, PII recommends a maximum of 20 students with one instructor.

Training Module 4d. SIS, 2 days. See PII Course 12

For this module, PII recommends a maximum of 20 students with one instructor.

Case Studies – Examples of Results Achieved on Building PHA/HAZOP Competency

PHA Leaders at UNITED (SABIC affiliate). This petrochemical site (ethylene, polyethylene, alpha-olefin) of about 600 employees determined that 4 PHA Leaders are needed for this size and nature of their production complex to handle PHAs and Revalidations and large MOC risk reviews (note that PII guidance would about 4 for major PHAs and 12 more for MOCs). The approach followed at UNITED was:

- Experts (PII, in this case) trained 15 process engineers to the knowledge level in leading and scribing PHAs (5 days)
- The PII instructor then chose the 8 best candidates, and coached them for 2 weeks while they led and scribed 3 different PHAs (re-do of existing units; initial PHAs during the capital project phase were poor)
- Training and coaching included all methods (HAZOP, What-If, Checklist, FMEA) with analysis of continuous mode, along with procedure modes for startup and shutdown
- During the PHA report-writing phase, PII coached, reviewed, and edited the draft PHA/HAZOP reports, with the UNITED leaders/scribes finishing
- By the end of the process, PII certified 4 leaders and 3 scribes
- These leader/scribes completed the PHAs of all modes of operation for all 4 plants and for utilities
- In the 5 years since, the leaders have been partially backfilled as a few were promoted to superintendent or manager or senior management
- Certified leaders/scribes have ensured that each PHA and each large MOC risk review was performed well

- See Figure 4 (provided earlier) for the overall competency progression for PHA Leadership competencies

PHA Leaders at CABOT (world-wide). This specialty chemicals and commodities company founded in 1882, employees about 4,500 employees world-wide, in 42 plants in 20 countries determined that about 100 PHA Leaders are needed world-wide to handle PHAs, major capital projects, and Revalidations and large MOC risk reviews.

- Experts (PII, in this case) trained about 100 process engineers and senior operations staff to the knowledge level of leading and scribing PHAs (5 days)
- For selected sites, the PII instructor and staff from CABOT select candidates from a course and coached them for about 1 week while they led and scribed different PHAs (re-do of existing units, to close gaps in initial PHAs)
- Training and coaching included all methods (HAZOP, What-If, Checklist, FMEA) with analysis of continuous mode, along with PHA of procedure steps for startup, shutdown, and online maintenance
- These leader/scribes completed the PHAs of all modes of operation for their sites

Note: When CABOT first began this path (6 years ago), they looked to develop LOPA competency. However, after a quick gap analysis of their current PHAs quality and thoroughness and current PHA competencies, they decided to build PHA competency instead (to prevent missing accident scenarios). Over time they have learned that PHA competency is much more critical than implementing LOPA.

PHA Leaders for MOCs (Only) at YANSAB (SABIC affiliate). This petrochemical site (ethylene, polyethylene, etc.) of about 1100 employees with about 800 employees in the technical departments, determined that 30 PHA Leaders are needed to handle PHAs (risk reviews) for small MOCs; the site has 2 experienced PHA leaders for large changes and for revalidations, and they contract PHA leaders and scribes for large projects.

- Experts (PII, in this case) provided 2 sessions and trained 15 process engineers in each to the knowledge level in leading and scribing PHAs (2.5 days)
- The PII instructor then coached each graduate for 2.5 days while they led and scribed many (up to 12) different PHAs of MOCs
- Training and coaching included only the What-If method, supplemented by the Checklist method (tailored to MOCs).
- Training included coverage of all types of changes (equipment, chemical, procedures, etc.) with analysis of continuous mode, along with analysis of procedure/batch modes of operation.
- By the end of the process, PII certified all but one leader (who was too inexperienced to qualify) as PHA leaders for MOCs.
- These leaders are currently completing the PHAs for MOCs at the site.
- See Figure 4 (provided earlier) for the overall competency progression for PHA Leadership competencies

PHA Leaders MOL Pakistan This natural gas processing plant, of about 600 employees with about 450 employees in the technical departments, determined that 15 PHA Leaders and Scribes are needed to handle PHAs (risk reviews) for small MOCs and large projects.

- In 2013, an expert (from PII) provided one session and trained 15 process engineers to the knowledge level in leading and scribing PHAs (5 days)
- The PII instructor then coached each graduate for 5 days while they led and scribed a redo of the PHA for the existing facility.
- Training and coaching included HAZOP, What-If, What-if/Checklist, Checklists, and FMEA methods
- Training included coverage of all types of changes (equipment, chemical, procedures, etc.) with analysis of continuous mode, along with analysis of procedure/batch modes of operation and training included redo or large units.
- By the end of the process, PII certified 4 leaders and 4 scribes as the starting leaders and scribes, who would eventually coach the remaining graduates of the classroom training, as needed.
- These leaders and scribes completed the redo of the site PHAs and they have been doing the PHAs for MOCs at the site ever since.
- See Figure 4 (provided earlier) for the overall competency progression for PHA Leadership competencies

CONCLUSIONS

Competencies for PHA leadership can be achieved and maintained at chemical process plants and companies. Organizations need to first recognize their gaps in competencies; this first step is a major failure of many companies, even the largest and oldest, because for some process safety needs, the organization may not know how to judge competencies. This is especially true of PHA/HAZOP Leadership where a high level of skill and experience is necessary. An organization needs to have existing experts in order to have the coaches/mentors available to build the missing process safety competencies; for the short-term, this may require a company to contract in the experts. Building competencies requires sustaining staff in a role long enough to build competency; and the organization must get a few of these competent staff to reach Advanced and Expert levels. Eventually, competency levels in PHA/HAZOP leadership can be self-sustaining; this is possible if the organization recognizes the importance of sustaining competencies and rewards those with very high level of competency accordingly.

ACRONYMS USED

AIChE – American Institute of Chemical Engineers
CCPS – Center for Chemical Process Safety (of AIChE)

FMEA – Failure Mode and Effects Analysis
GCPS -- Global Congress of Process safety
HAZOP – Hazard and Operability; as in HAZOP Analysis or HAZOP Study
LOPA – Layer of Protection Analysis
MOC – Management of Change
PHA – Process Hazard Analysis
PSM – Process Safety Management
RAGAGEP – Recognized and Generally Accepted Good Engineering Practice

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2. PII's Minimum Standards for PHA/HAZOP Leaders
3. PII's Path to Competency for PHA/HAZOP Leaders
4. Excerpts on Learning Objectives and Competency Requirements from various PII Training Manuals.

Appendix 1

© Minimum PHA Leadership Competency Requirements within PII

Based on training more than 5,000 PHA leaders and certifying hundreds of leaders, the minimum competency requirements for PHA leaders are listed below:

PHA Leaders for Small Changes

- Bachelor's degree in engineering
    - Chemical engineering preferred, but BS ME also acceptable; and other engineers acceptable if they have enough chemical process experience
    - Equivalency would be about 10 years in operations role without a degree, but then understanding of thermodynamics and transport phenomena will be weaker and documentation skills will likely also be weaker
- Minimum of 4 years' experience (for BS ChE)
- At least 2 years in operations or production engineering role

- Candidate has completed training in a (minimum 2 days) PHA leadership course (for at least small changes) that covers how to lead PHAs of all modes of operation:
    - Make sure the initial PHA Leaders and Scribe training covers this scope and make sure it also covers how to consider all damage mechanisms
    - Instructor evaluates this attendee as Excellent or Very Good (see the sample scoring sheet on the next page)
    - See attached course outline
- Candidate has been coached by an existing Subject Matter Expert (SME) for 2-3 days during PHA of 4 to 8 MOCs, with actual PHA team members
- Candidate completes 6 more MOC PHAs without coaching, which are judged as acceptable by SME on PHA of MOCs
- SME certifies competency of PHA leader for MOCs.

PHA Leaders for Units and Projects

- Bachelor's degree in engineering
    - Chemical engineering preferred, but BS ME also acceptable
    - Equivalency would be about 10 years in operations role without a degree, but then understanding of thermodynamics and transport phenomena will be weaker and documentation skills will likely also be weaker
- Minimum of 7 years' experience (for BS ChE)
- At least 5 years in operations or production engineering role

- Candidate has completed training in a (minimum 4 day course) PHA leadership course that covers how to lead PHAs of all modes of operation and how to address all damage mechanisms at each equipment node:

  - Make sure the initial PHA Leaders and Scribe training covers this scope
  - Instructor evaluates this attendee as Excellent or Very Good (see the sample scoring sheet on the next page)
  - Training to teach how to use:
    - What-if method of continuous mode of operation
    - HAZOP method for continuous mode of operation (focused on nodes of equipment)
    - 2 guideword and 7 guideword analysis of step deviations for non-routine modes of operation
    - What-if of procedures
    - Review of all damage mechanisms
    - See attached course outline
- Candidate has been coached by an existing SME for large PHAs during 1 to 3 weeks of PHA meetings, with actual PHA team members
- Eventually, candidate completes 2-3 more weeks of PHA meetings without coaching, along with associated documentation of the results.
- SME certifies competency of PHA leader for large PHA

PHA Leaders for Revalidations of Units and Projects

- Candidate has attained status as PHA Leader for Units and Projects
- Minimum of 8 years' experience overall
- At least 5 years in operations or production engineering role.
- Candidate has completed training in a (2-day minimum) PHA Revalidation Training.
  - Make sure the initial PHA Leaders and Scribe training covers this scope
  - Instructor evaluates this attendee as Excellent or Very Good (see the sample scoring sheet on the next page)
  - See attached course outline

- Candidate has been coached by an existing SME for 1 weeks of PHA meetings and for about 1 weeks of pre-meeting and after-meeting effort combined, during actual PHA Reval(s) with actual team members
- Eventually, candidate completes 1 PHA Revalidation without coaching.
- SME certifies competency of PHA leader for PHA Revalidations

2-Day PHA Leadership for Small Changes (MOCs) Course

Day 1 (8:00 a.m. to 4:00 p.m.)

- Introduction
  - Learning objectives
  - Overview of process safety management
  - Overview of PHA requirements
  - Overview of MOC requirements

- Overview of risk review methods
  - Methods and their usefulness over the life cycle of a process
  - Human factors concepts and how to address human factors during hazard evaluations
- Preparing for the PHA of an MOC
  - Scoping the analysis
  - Deciding of What-If Analysis alone is sufficient for the analysis of a change
  - Choosing the team members
  - Logistics and procedures for pre-meeting, meeting, and post-meeting tasks
- What-if/checklist technique
  - **Workshop: Example What-if (instructor-led)**
  - **Workshop: What-if review of a Process Change (1)**
  - **Workshop: What-if review of a Process Change (2)**

Day 2 (8:00 a.m. to 4:00 p.m.)

- PHA Documentation
  - Analysis documentation, results, and follow-up
- What-if/checklist technique (more practice)
  - **Workshop: What-if review of a Process Change (3)**
- What-if/checklist technique applied to changes to operating procedures
  - **Workshop: What-if review of a Procedure (only) Change**
  - **Workshop: What-if review of a Procedure (only) Change (1)**

- Checklist analysis as supplements to brainstorming methods
- PHA Documentation
  - Analysis documentation, results, and follow-up

- *OPTIONAL:* Hazard Evaluation Software - functions and features
  - Workshop: Using LEADER software to prepare for and document hazard evaluations/risk reviews

- *Course examination*

5-Day PHA Leadership Course for Units or Projects

Day 1 (8:00 a.m. to 4:00 p.m.)

- Introduction
  - Learning objectives
  - Overview of process safety management
  - Risk assessment concepts
  - Overview of PHA requirements
- Overview of risk review methods
  - Methods and their usefulness over the life cycle of a process
  - Making risk judgments
  - Human factors concepts and how to address human factors during hazard evaluations
- Preparing for the hazard evaluation (risk review or PHA)
  - Scoping the analysis
  - Choosing technique and level of detail and sections
  - Choosing the team members
  - Logistics and procedures for pre-meeting, meeting, and post-meeting tasks
- What-if/checklist technique
  - **Workshop: Example What-if (instructor-led)**
  - **Workshop: What-if/checklist review of a continuous process**

Day 2 (8:00 a.m. to 4:00 p.m.)

- HAZOP technique
  - **Workshop: Example HAZOP (instructor-led)**
  - **Workshop: HAZOP review of a continuous process**
- Analysis documentation, results, and follow-up
  - **Workshop: HAZOP review of a continuous process (continued)**

Day 3 (8:00 a.m. to 4:00 p.m.)

- Damage mechanism review (during Loss of Containment deviation of each node)
  - **Workshop: HAZOP review of a continuous process (continued)**
- HAZOP/what-if techniques for analyzing procedures and batch processes
  - **Workshop: Example HAZOP of a procedure (instructor-led)**
  - **Workshop: HAZOP/what-if reviews of batch processes and procedures**

Day 4 (8:00 a.m. to 4:00 p.m.)

  - **Workshop: HAZOP/what-if reviews of batch processes & procedures**
- Failure Mode Effect Analysis (FMEA)
  - **Workshop: FMEA of a critical auxiliary system**

Day 5 (8:00 a.m. to 3:00 p.m.)

- Checklist analysis as supplements to brainstorming methods
  - **Workshop: Using Checklists after brainstorming methods**
- **Workshop: Estimating the schedule and labor required to perform a PHA**
- Software Training
- **Workshop: How to use software to prepare for and document hazard evaluations/risk reviews**

- *Certification exam (optional)*

2-Day PHA Leadership Course for Revalidations

Day 1 (8:00 a.m. to 4:00 p.m.)

- Learning objectives and goals of revalidation
- Overview of PSM requirements for PHAs and Revalidations
    - Terms and definitions
    - Determining your goals (minimal compliance versus meeting the needs of procedure writers, trainers, and equipment reliability departments)
- Gathering required information
    - Previous PHA report and recommendation closure documents
    - Incident reports since previous PHA cycle
    - MOC records
    - Current P&IDs and P&IDs as existed during previous PHA cycle
    - Current SOPs and SOPs as existed during previous PHA cycle
    - **Workshop: Review of previous versus current documents to determine if MOC has worked adequately**
- Assessing the previous PHA report and other data
    - **Workshop: Compliance/Quality review of an example PHA**
- Considering "lessons learned"
- Defining the revalidation approach
- **Workshop: Choosing the revalidation approach (for an example PHA and set of gathered data)**

Day 2 (8:00 a.m. to 4:00 p.m.)

- Conducting the revalidation (including PHA of changes not reviewed well enough before, while combining results of MOC risk reviews and II/RCA results into the baseline PHA)
- **Workshop: Revalidating a PHA (multiple examples)**
- Documenting the revalidation (especially combining results of MOC risk reviews and II/RCA results into the baseline PHA)
- **Workshop: Revalidating a PHA (multiple examples)**
- *Certification examination (optional)*