Best Practices for PHA Revalidations

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Prepared for Presentation at
American Institute of Chemical Engineers
2018 Spring Meeting and 14th Global Congress on Process Safety
Orlando, Florida
April 22 – 25, 2018

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Keywords: PHA, Revalidation, process safety, PSM

Abstract

Process hazard analyses (PHAs) must be updated and revalidated every 5 years or sooner. PHA/HAZOP Revalidation is entirely different than a baseline or original PHA. The original textbook from CCPS on Revalidating PHAs was issued in 2001. This paper describes the current best practice approaches to revalidation and explains when to use each approach. The approaches are described in detailed flowcharts. Checklist for decisions making and quality control are provided, along with examples of completed documentation. This paper is based on completion of more than 300 Revalidations.

1. Introduction

A PHA Revalidation is a renewal at one point in time of an existing PHA to ensure the risk review for the entire unit/process is still valid. It is one stage during the lifecycle of a PHA of a process.

Prior PHA(s) + Update + Retrofit + Review (MOCs & Incidents) → ***Revalidated PHA***

Revalidations are done after the initial PHA and after the startup phase of a process. They are done throughout the life of a process until it is decommissioned. Reference Figure 1 below showing the types of hazard reviews during the life cycle of a process.

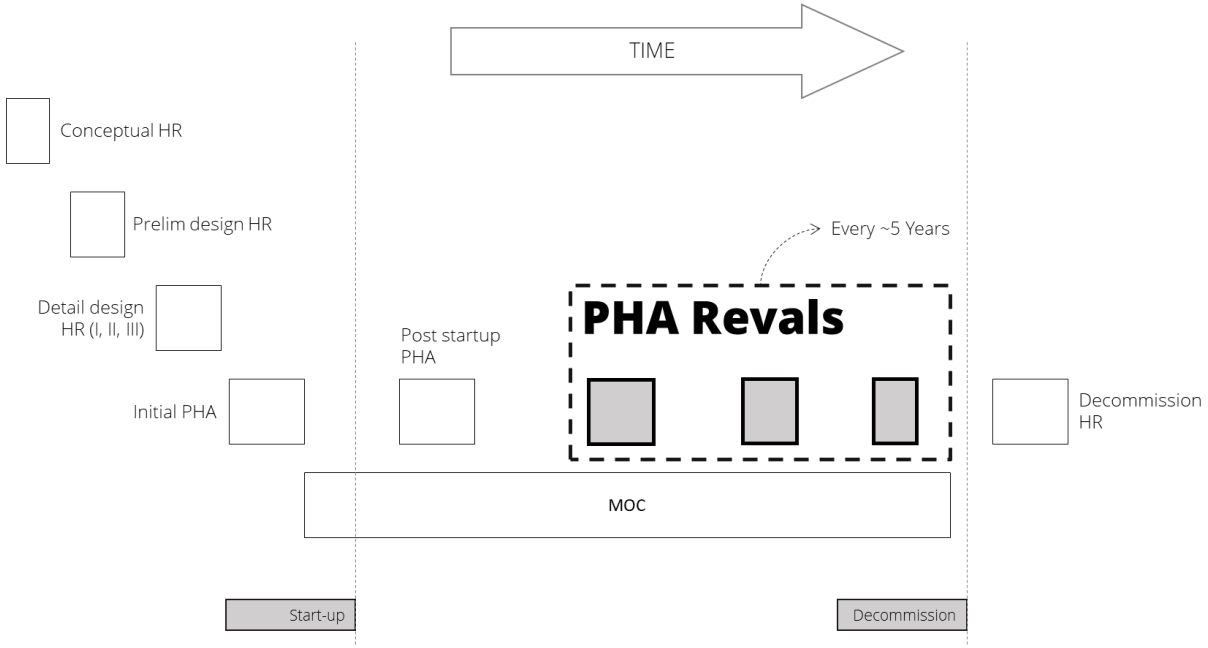

Figure 1. PHA Revalidations in a Unit's life cycle

Revalidating and updating the results of any previously conducted PHA(s) are both essential if risk is to be maintained. Therefore, a Revalidation PHA should be conducted on all "Initial" PHAs after five years, and then revalidated again each successive 5-year period. The primary objective of the Revalidation is to review the results of previously conducted PHAs and identify, evaluate and attempt to control any new hazards that have been introduced or discovered since the original PHA.

The original textbook, Revalidating Process Hazard Analyses, 2001, CCPS/AIChE [1], was written bases on the experience from a limmited number of Revalidations. Most PHAs between 1992 and 2003 were ReDo PHAs. This paper updates the state-of-the art on Revalidating PHAs and is based on thousands of revalidations by PII staff [2].

2. Why do we revalidate?

The underlying driver for revalidations is process changes. The PHA is updated to reflect the current process and to evaluate hazards of the current process and the controls for mitigating or eliminating the hazards. Operating history may also identify scenarios that the previous PHA did not address or that make documented safeguards and consequences invalid. These scenarios must be reviewed and added to the PHA.

Process changes

Changes are made to the process, materials, procedures, facilities, and equipment. MOC systems are implemented to review hazards associated with changes and to document the change to facilitate updating process safety information needed to maintain safeguards. Even with the MOC system, changes should be reviewed individually and then collectively to assess the quality of the hazard review completed at the time of the change.

Some changes are made to the process without using the MOC system. These uncontrolled and undocumented changes can invalidate the documented design basis of the process and can introduce uncontrolled hazards.

The accumulation of process changes since the last PHA can introduce hazards that may not have been identified or even possible (credible) during the review of a single process change.

Quality of previous PHA

Company guidelines and government regulations define requirements for PHAs. PHAs must address certain elements of any process such as human factors and process safeguards.

Furthermore, PHA methodologies can be incorrectly executed during the PHA meeting. Examples include not having a knowledgeable and experienced PHA team, or using only the What-if technique for a complex process unit.

Operating history & research

Since the previous PHA, new information emerges through additional years of operating the process and possibly through research and development prompted by incident investigations and near misses and through process improvement initiatives. Armed with new information, previous assumptions about causes, consequences and safeguards associated with process deviations may change. The revalidation process provides the opportunity to apply new findings to previous PHA results.

Previous PHA Recommendations

The revalidation team should discuss and study the recommendations generated from the previous PHA. The revalidation meeting is not the forum to resolve the recommendations. Furthermore, those with the authority to make resolution decisions may not be members of the PHA revalidation team. The team may evaluate why a recommendation is still Open. However, the team my find during the revalidation that the same recommendations resurface, further validating the need for the recommendation. Obviously, NO recommendations should still be open after 5 years, but sometimes they are.

Review of the recommendations also functions as an audit as the implemented recommendations are reviewed. Since all recommendations are considered process changes, the MOC system should be used to properly identify hazards and to update process information. If no MOC

documentation is available, then the implemented recommendation must be considered an uncontrolled change and must be reviewed during the PHA revalidation.

Finally, review of the closure of the previous recommendations is necessary to help ensure that the previous PHA tables are updated for the new and revised safeguards that the recommendations typically result in. Resolution of recommendations may also result in elimination of accident scenarios.

Regulatory & company requirements
Government regulations and company requirements typically establish the need to revalidate, the frequency of revalidation, and the scope of the revalidation. Regulations and company requirements can also change, prompting PHA revalidations.

Decommissioning of process equipment
The processes involved in decommissioning process equipment (e.g., decontaminating, dismantling, disposal) present new risks that were likely not applicable during routine process operations. There may also be different/new deviations for emptying or cleaning the equipment. The scope and complexity of equipment being decommissioned will likely dictate the need for a new PHA in lieu of a revalidation.

3. How do we revalidate?

There are three major approaches to perform a PHA Revalidation:

Update (& Revalidate)
Updating the PHA to reflect process changes and incidents that have occurred since the previous PHA. If the plant has (1) a strong, effective MOC system and (2) a thorough, well-documented PHA, that was performed correctly with the right team, then updating and revalidating will be more streamlined. For uncontrolled changes and for documented changes where documentation is limited, and/or the hazard review is of poor quality, a more extensive review of the PHA section deviations is required.

Process changes are discussed while referencing the corresponding "node" or section, analyzing the effect of the change on the process deviation, and the causes, consequences and safeguards that are documented in the previous PHA report. The report is updated to reflect the process changes.

For incidents, discuss if the incident scenario was documented in the previous PHA. If so, determine if documented safeguards failed or if they were adequate. For incidents that uncover a new hazard, the team then applies the PHA methodology to the incident scenario and updates the PHA under the applicable section.

Evergreen: This is the simplest mode of revalidation, but only the companies with very mature PHA systems and good staff continuity can implement this approach. With this approach, a company updates the baseline PHA as the final step of each MOC (or every month); so the PHA is always Up To Date, or at worst about 1 month behind the latest MOC. This approach requires continuity of PHA team leaders between unit-sized PHAs and mini-PHAs for changes (MOCs). It also requires that the same software is used for MOC PHAs and unit-sized PHAs. This approach requires a high quality and thorough baseline PHA. It uses codes, in brackets, to note which MOC or incident the new information came from. See the excerpt on the next page.

(A.3) (Reviewed 2005) Measuring Level on Bulk Storage Tanks					
Drawing: SP 03.201.02					
Item	**Deviation**	**Causes**	**Consequences**	**Safeguards**	**Action Items**
33.7	Step 2 (old Step 4) to remove measuring stick and record level performed incorrectly		(1998) No consequences of interest (2005) Operator could fall resulting in serious bodily injury (2005) Resin spill could damage valve	(2005) Railing around work area on tanks	
33.9	Skip step 4 (old step 6) to replace cap on quick connect	Typical causes of procedural errors (see Table A.1)	Release of process material if preparing to unload a tank wagon into the tank; fire and explosion hazard affecting a large area	Continuous ventilation The tanks are located in a containment area Checklist Generic and inherent safeguards protecting against or mitigating process material releases (see Table A.2) (2005) Air Monitors in Bulk room	'98Rec 26. See recommendation 19, item 29.12 (1998)
33.10	Step 4 (old Step 6) to replace cap on quick connect and pull ears up and secure Velcro straps performed incorrectly (poor seal when cap is replaced)		(2005) Quick connect cap can pop off during the filling stage and flammable material can spill out of tank; fire hazard affecting a medium area Incident Report 2/12/03 - Bulk Room - 878 Resin leak from valve on bulk resin tank during resin tanker unloading - (A.9) (Added Reval 2005) Incident Investigation Reports and Spill Reports 1998-2005 (linked to 82.11) MOC 92-2005-04 - 4/1/05 Replace portable tank valve lever stainless actuator to oval actuator brass construction - (A.8) (Added Reval 2005) Management of Changes 1998-2005 (linked to 81.23)	(2005) Velcro straps on valves	

So, if the organization intends to keep their baseline PHA evergreen, then the PHA Leaders and Scribes of MOC risk reviews need to learn how to find and edit the baseline PHAs. At revalidation time (every 5 years), a PHA team of the proper composition is convened, but now their primary responsibility becomes making sure no changes were missed, making sure each mini-PHA had the right team structure, and making sure the Revalidation team consider the effect of the combination of MOCs and IIs since the prior PHA, as each MOC PHA team only considered the effect of that specific change on the baseline PHA

Retrofit (Update and Revalidate)
Retrofits are necessary when the PHA methodology was incorrectly applied or specific guidelines/requirements were not addressed, such as human factors considerations. In this scenario, the team would review each section of the previous PHA and correct any deficiencies. If human factors were not addressed, the team would go back and review each section, applying human factor concepts as causes. The team may also need to apply the global human factors checklist if it was not addressed before. In summary, if requirements were omitted, the previous PHA should be a candidate for a retrofit.

Retrofits are also necessary if there are holes in the previous PHA. In this case, the hole can be patched. Holes can include failure to evaluate one or more modes of operation or missing the hazard review of a selected equipment/sub-units. Retrofit could also include performing a facility siting review that was omitted in the previous PHAs.

Redo
A Redo is basically starting over and is more like doing an initial PHA. A Redo starts with up-to-date P&IDs and other PSI and operating procedures. Redo is needed where PHA methodology was incorrectly applied and cannot be corrected. For example, if the team composition was wrong or if a less extensive methodology was used for a very complex process, a redo is typically suggested. A Redo may also be necessary if there were substantial changes to company policy or government regulations regarding PHAs.

3.1. Deciding on the Revalidation approach to use

Figure 2 shows the decision making process to choose the Revalidation approach to use.

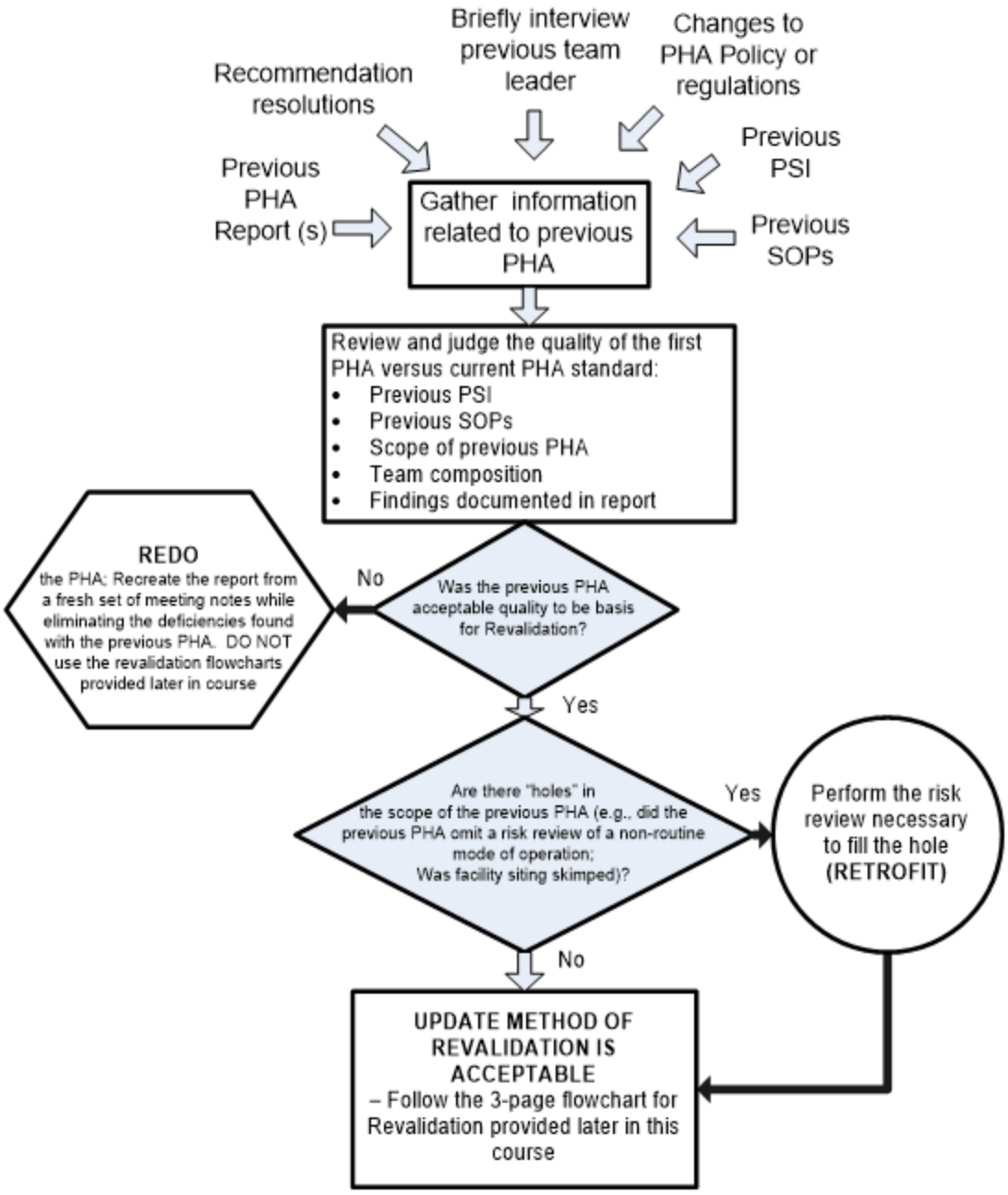

Figure 2. Decision making process for revalidation approach

To answer the question in Figure 2 "Was the previous PHA acceptable quality to be the basis for revalidation?" use the checklist shown in Table 1. A "No" answer to any of the questions indicates a Redo is likely necessary (sometimes two "No" answers make more sense).

Table 1. Determining the Quality of the Previous PHA

CRITERIA	Yes/No
1. Did the qualifications of the PHA leader/facilitator meet all company and regulatory requirements; i.e., was the leader/facilitator trained, experienced and competent in the PHA method used?	
2. Did the PHA Team make-up/qualifications meet all company and regulatory requirements; Did team include, as a minimum the disciplines listed below? • a stable team membership roster with minimal substitution of team members during the course of the review • operations team member(s) with adequate process and equipment knowledge including recent hands-on operating experience (preferably a senior hourly operator or at-risk operator) • an engineer with industry and specific process experience	
3. Was the prescribed PHA method appropriate for the complexity of the process studied; i.e., was the PHA method justly rigorous for addressing all potential hazards of the process?	
4. Was the PHA method used from the approved list below or was an appropriate equivalent methodology used? • What-If • Checklist • What-If/Checklist • Hazard and Operability Study (HAZOP) • Failure Mode and Effects Analysis (FMEA)	
5. Is the PHA documentation sufficient, or can sufficient documentation be reconstructed, to: • verify PHA leader/facilitator and team qualifications • indicate PHA team meeting dates • verify that previous incidents, including those with the potential for catastrophic consequences, were reviewed by the PHA team • verify the PSI utilized by the team was adequately available and up-to-date and accurate enough to ensure a thorough study • verify the PHA team's findings including daily worksheets, engineering and administrative controls cited (safeguards), the failure of controls (consequences), and their causes; do these findings appear to make sense and are they thorough, or does a significant number of critical scenarios appear to be missing? • verify that siting was addressed • verify that human factors were addressed • verify that a qualitative evaluation of a range of the possible safety and health effects was conducted (risk ranking or some other documented technique) *Note: if only a few of these bullets are an issue, they are probably "fixable," however, if several of them are an issue, then there is probably a sufficient lack of data to warrant a "No" answer.*	

4. Revalidation process

4.1. Preparation

The preparation (pre-meeting) stage of a PHA Revalidation has two main tasks (see Figure 3):

- Information gathering
- Information evaluation

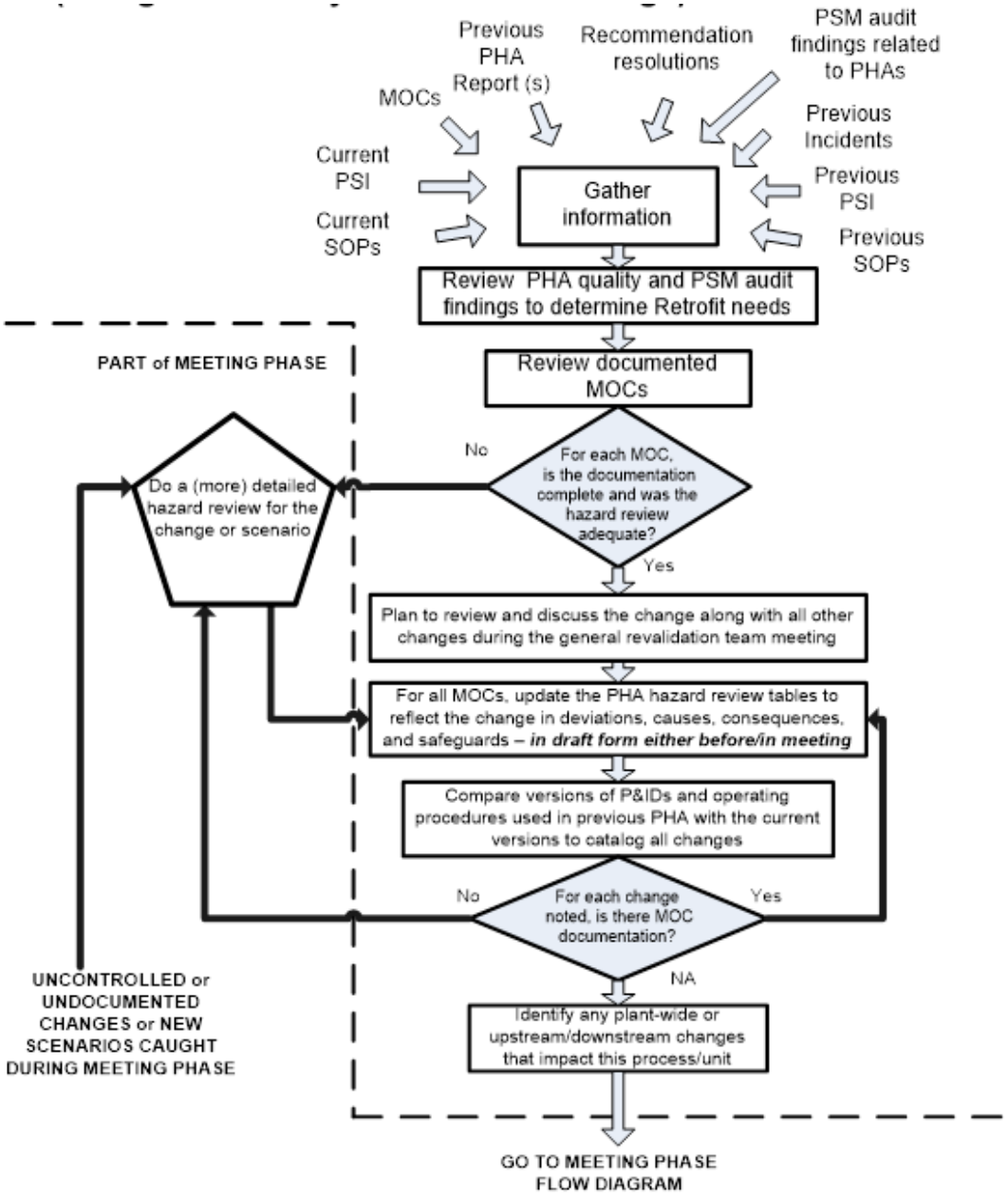

Figure 3. Revalidation: Pre-meeting activities

4.2. Meeting

Figure 4 shows a flowchart of the meeting phase activities.

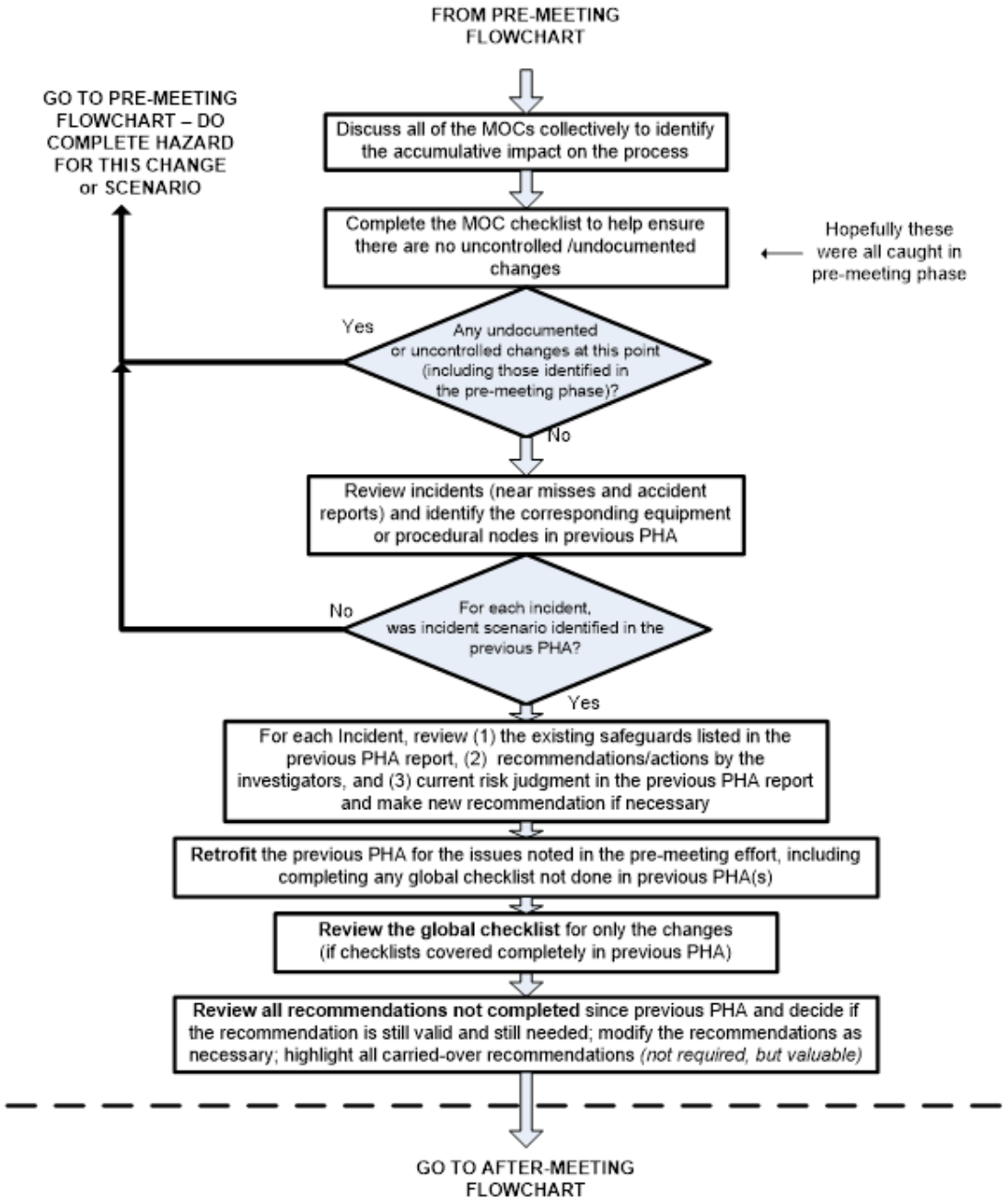

Figure 4. Revalidation: Meeting activities

4.3. After meeting

Figure 5 shows a flowchart of the after meeting phase activities.

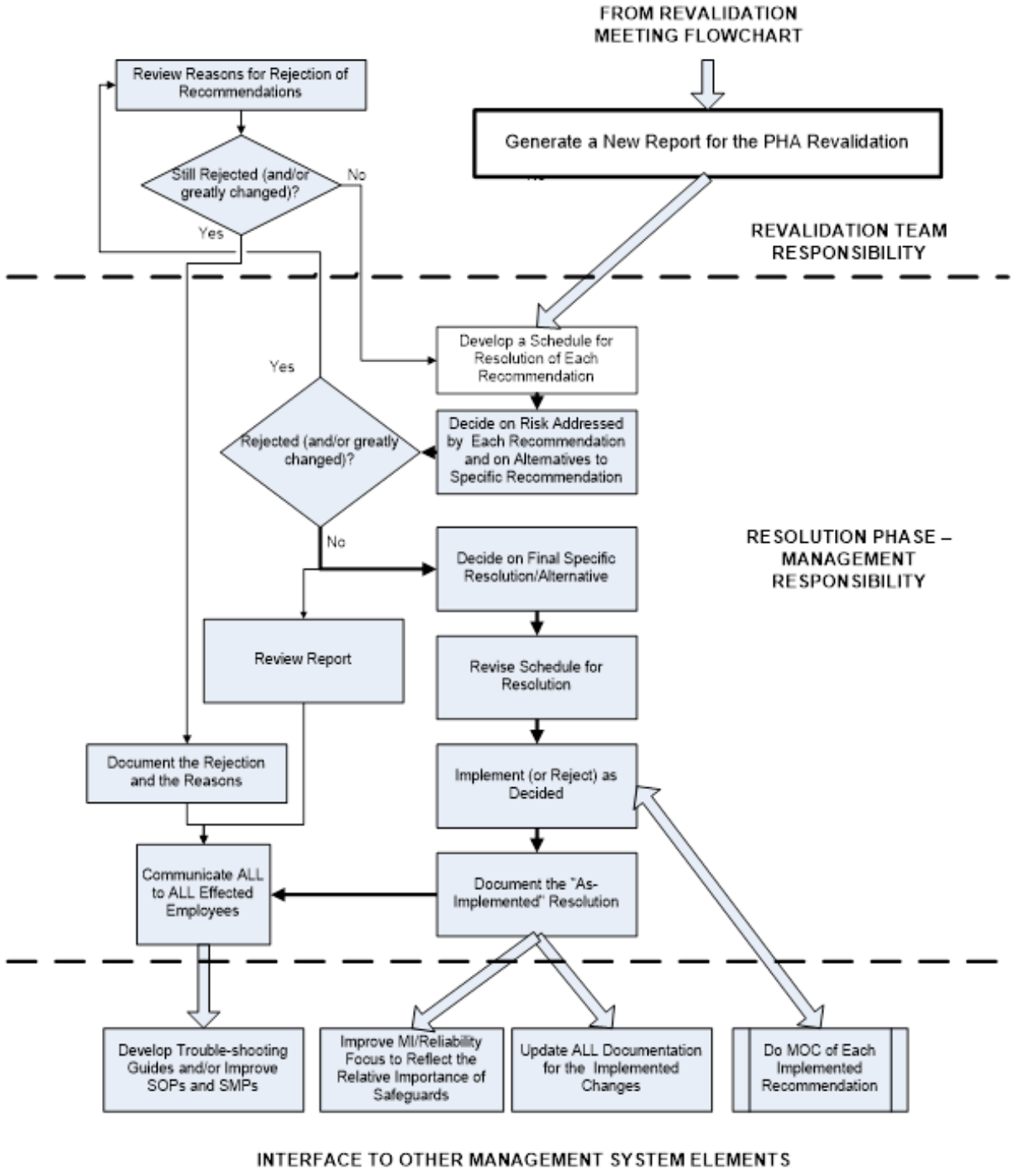

Figure 5. Revalidation: After meeting activities

5. Revalidation team

Nothing is more important to the success of the hazard evaluation revalidation than the Team. The team leader and scribe help ensure a concise revalidation while the team members do most of the brainstorming of accident scenarios based on their expert understanding of the process and their experience. The best techniques cannot compensate for a poorly staffed team.

5.1. Team Leader

The team leader is often viewed as the most important member of the hazard evaluation/revalidation team. But, the team leader is NOT more important than the others on the team; the leader's (facilitator's) role is difficult to learn because the principal job of the leader is to ensure the team has a good chance to uncover all accident scenarios while balancing the need of not wasting the team member's time. Typically, team leaders have the following traits:

- experience in process engineering, process safety, engineering standards
- trained and experienced in hazard evaluation technology
- trained in revalidation approaches
- unbiased with respect to the process design and operation
- skilled facilitator; does NOT let the team rely on him/her to make risk decisions
- well organized; saves time in the meetings at every opportunity
- good writing skills; able to summarize recommendations well

The best revalidation team Leaders are those that (1) make good judgments on revalidation approaches, (2) make good decisions on when to force a risk judgment by the team, (3) recognize when the team is wasting time on a discussion, and (4) make the brainstorming techniques "invisible" (the brainstorming seems to flow on it's own).

5.2. Scribe

The Scribe is optional for Revalidations, but it efficient to use one.

A good scribe takes the load off of the team by recording the notes of the hazard evaluation team discussion. A scribe needs to be able to listen to roughly 10,000 words of discussion on a complex accident scenario and be able to distill the discussion into roughly 100 words of written record. The scribe probably has the toughest job on the team and is critical to the team's success because the scribe allows the team to freely brainstorm. Key traits of a good scribe include:

- trained in analysis techniques
- trained in revalidation approaches and has the time to help the leader do the large amount of pre-meeting reviews
- attentive to details; able to decide quickly and without guidance where to show each step of the scenario in the hazard evaluation record
- bears complete documentation burden during the meeting (frees the leader to LEAD)
- well organized; saves time in the meetings at every opportunity
- excellent writing skills; able to distill the scenarios into concise descriptions

Sometimes the scribe role is filled by a Leader who is still in training. Other times we use junior engineers for this role since they will learn how "not" to operate the process. In a few cases, administrative assistants have been screened and taught how to scribe a hazard evaluation meeting (the jargon and the logic of an accident scenario can be difficult for non-technical

persons to learn). In all cases, the scribe must have the time allocated for the large documentation load they will bear.

5.3. Team members

As with the initial PHA/hazard evaluation, the team members are the most important part of the revalidation team because they are the only ones with the expertise to brainstorm possible accident scenarios. Good team members can even compensate for poor leadership of the team. Certain team members (such as the unit operator or the process technology expert) are mandatory members of the team – if one of these mandatory members must be absent, they must be replaced "in kind" or the team meet must be halted until they return. Other team members (such as loss prevention or maintenance) may be part-time or temporary – their expertise is only needed for an hour of each 5-hour meeting-day to answer questions related to their expertise. The decision on who is necessary for any given discussion should rest with the team leader and can vary from session to session. The traits we want in our team members include:

- expertise in process design, operations, and maintenance
- listens attentively during discussions
- respects opinions of others
- actively contributes to discussion
- brainstorms — gets past status quo
- can't be distracted by other duties during meeting phase
- openness about previous problems in the process/operation

6. Time requirements

As expected, the time required for a PHA Revalidation is lower than the time required for the Initial PHA (unless the Revalidation is performed by a Redo).

For Revalidation there's a higher burden on the Leader (and Scribe) before the meetings since they have to gather and evaluate all the information available. However, meeting and documentation time are greatly reduced comparing with the Initial PHA. The better the quality of the Initial PHA (and the information required) the lower the time required for Meeting and Documentation stages.

Figure 6 compares the time requirements for Initial PHA and PHA Revalidation.

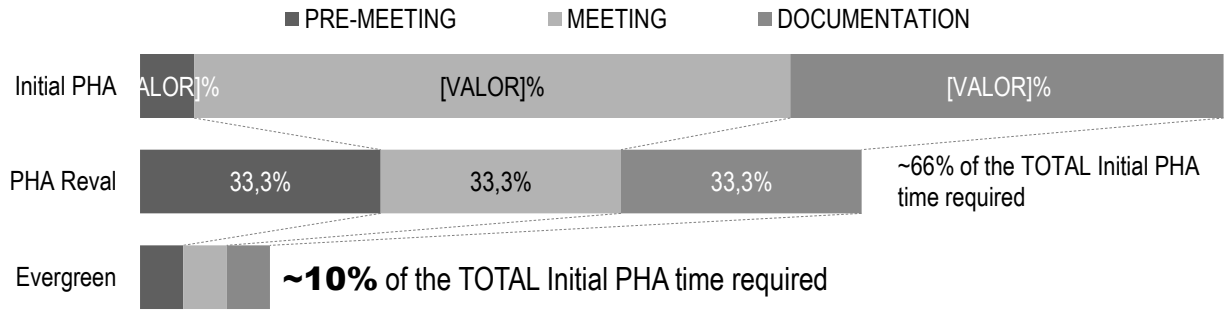

Figure 6. Time requirements comparison. Initial PHA vs. PHA Revalidation.

7. Conclusions

Revalidating and updating the results of any previously conducted PHA are both essential if up-to-date and accurate Process Safety Information is to be maintained. Therefore, a "Revalidation" PHA should be conducted on all "Initial" and "Capital Project" PHA's after five years. The primary objective of the "Revalidation" PHA is to review the results of previously conducted PHA's, and identify, evaluate and attempt to control any new hazards associated with the original PHA. Following the best practices described in this paper is a key step for achieving that goal in an efficient way.

8. References

1. *Revalidating Process Hazard Analyses*, 2001, CCPS/AIChE.
2. PII Course 9, *PHA Revalidation*, © 2003-current