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A Joint AIChE and CCPS Meeting

The Hazards Next Door: Streamlining PHAs in Utilities and Ancillaries

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Prepared for Presentation at
American Institute of Chemical Engineers
2025 Spring Meeting and 21st Global Congress on Process Safety
Dallas, TX
April 6-10, 2025

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Keywords: Process Safety, Process Hazard Analysis, Checklist, What-if, Utilities, Ancillaries

Abstract

Almost every industrial process has ancillary and utility processes to deliver essential energy and maintain stable conditions for uninterrupted, optimal performance. While potential interruptions in these systems are often considered within the main process PHA, the specific risks and reliability of utility and ancillary processes are evaluated inconsistently across companies and industries. This session will present a case study on a streamlined hazard analysis methodology that provides a thorough risk assessment for utility and ancillary processes without requiring the extensive resources of a full HAZOP study.

This methodology employs a dual approach: a checklist aligned with Recognized and Generally Accepted Good Engineering Practices (RAGAGEP), combined with a targeted what-if analysis to assess and address any identified reliability and safety gaps. The checklist ensures that system design meets RAGAGEP standards, while the what-if component evaluates specific risks and confirms that adequate safeguards are in place.

The data gathered through this streamlined approach is compared to outcomes from full-scale hazard assessments, demonstrating effective hazard identification, risk mitigation, and resource efficiency. This presentation will illustrate how companies can adopt this method to achieve comprehensive safety insights with significantly reduced effort and cost.

1 Introduction

Hazard and Operability Studies (HAZOP) are the industry standard for a process hazard analysis for most processes. However, it is very resource intensive, typically only the first step in quantifying risk, and does not always return on the investment put into it for utility and ancillary systems (see figure 1). Many utility and ancillary processes are less complex, have more uniform hazards, and straightforward safeguards causing many to see their risks as trivial. Worse, the risks in utilities and ancillaries are sometimes overlooked as they are seen as companions to the “real processes.” There is a clear benefit to having a more streamlined way to analyze the risks to avoid these common pitfalls.

The method presented in this paper aims to reduce the time it takes to analyze hazards in utility and ancillary processes without compromising the quality of the assessment. The streamlined method involves two parts. First, a checklist to compare the process design to Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) standards to verify the reliability of the utility in the users PHA. Second a structured what-if list to discuss potential hazards and quantify the risk using a risk matrix to ensure enough safeguards are in place to address the risk. This can be a more concrete exercise if desired by using LOPA methodology in the what-if discussion to identify specific initiating events and independent protection layers.

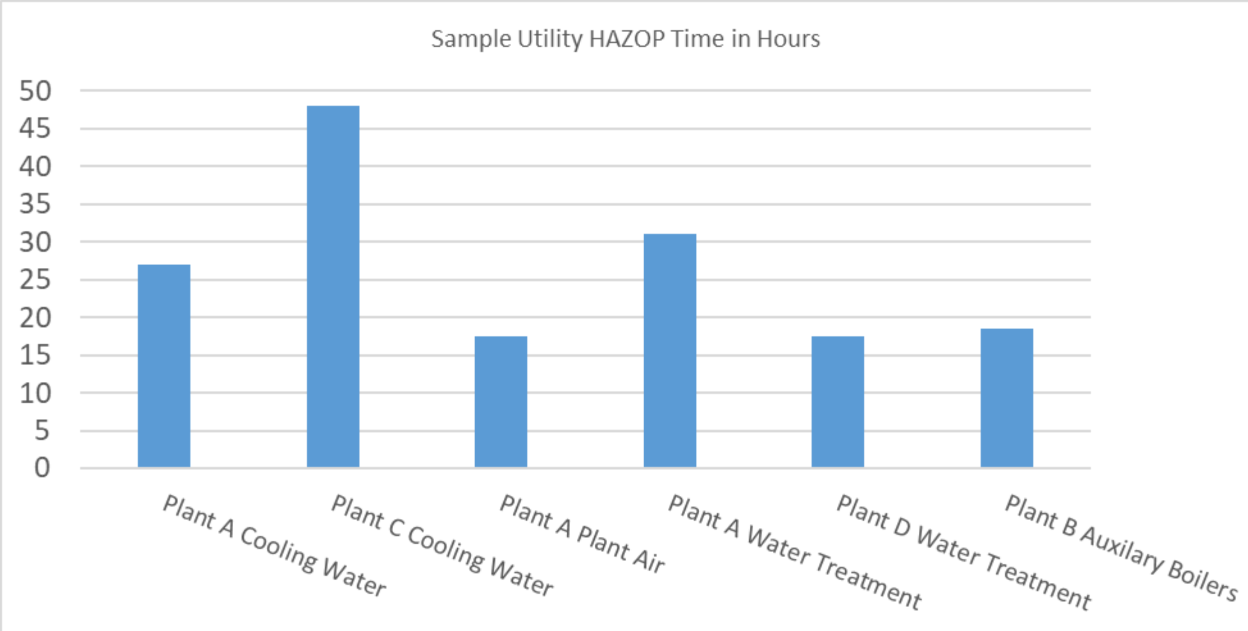

Figure 1 – A sample of utility HAZOP times in Nutrien. These studies take many days but typically yield lower priority recommendations.

2 Identify Candidates for the Methodology

A loss of utilities should be considered in every PHA methodology, but a frequent question is how far back into the utility should the process PHA reach? If the hazards of the loss or disruption of the utility are addressed at least once per relevant parameter in HAZOP, for example, the rest of the failure modes for that utility can be addressed in a separate more streamlined study. In the example in figure 2, the highlighted portion would be included in the process HAZOP including the valves on the utility side of the heat exchanger so they can be discussed in the HAZOP. If there were no valves, a portion of the utility streams should be included in the node to ensure they are discussed. Utilities that are only covered by PSM because of their impact on nearby process are ideal candidates for the streamlined method. Examples include cooling water, water treatment, plant air, steam generation and distribution, and condensate handling. However, it often depends on complexity, uniqueness, and interconnectivity.

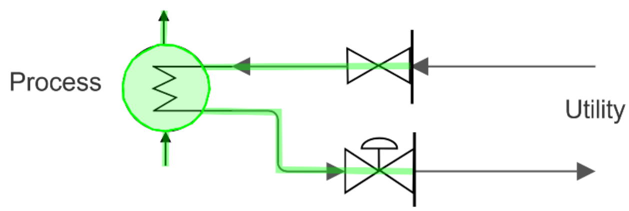

Figure 2 – the process PHA should include the highlighted portion in the node with the remainder of the utility covered using the streamlined method.

3 Collect Data

For an example, let us examine a hypothetical cooling water system including a cooling tower, pumps, distribution and return headers, and chemical addition tanks.

The first step in creating a streamlined method for a utility is to gather the relevant data. For the reliability portion, typical sources of RAGAGEP are a great start. What industry codes and standards apply to the equipment? Are there vendor documents with information on how to properly maintain the equipment? Does the company have standards that should be consulted for best practices? As a final check, what does the repair history for the process look like? This will shed light on areas of focus to improve reliability. While it may not all be used in the checklist, the more data we gather the more useful our checklist will be.

The safety portion should come from collecting documented hazards from a process as similar as possible to the one being analyzed. Prior HAZOP data is an excellent source and if the process being studied does not have one of its own, third parties can offer relevant HAZOP data from similar processes. Company data bases often contain previous incidents related to the area being studied that should be included. Incidents in similar processes studied by organizations like CCPS, CSB, and EPSC are essential for completing a hazard library for the studied equipment. Be sure to consider all parts of the process. For our example in cooling water system we have included chemical addition tanks. Therefore, we mustn't forget truck unloading hazards, including unloading into the wrong tank when collecting our incidents.

4 Create A Checklist and Structured What-if

When developing a checklist is it important to remember the primary focus: Reliability. While reliability and safety often go hand in hand, the specific safety hazards will be addressed in the what-if portion where risk can be quantified and safeguards are considered. The checklist is simple looking for adherence to RAGAGEP to ensure the loss of utilities occurs at a frequency consistent with the assumptions of main process PHA. Now ask, what are the most important guidelines for reliability in our process. Returning to our cooling water example we might list:

- A program to inspect the chemical makeup of cooling water
- Documented responses to upset conditions in cooling water chemistry
- A program to inspect equipment
- A preventative maintenance program on equipment critical to reliability
- Redundant equipment to address failures
- Preventing overpressure leading to reliability upsets
- Concerns related to past equipment failures

For safety, generate a What-if checklist addressing the common hazards obtained in the previous section. Some hazards applicable to our example:

- Personnel exposure to treatment chemicals
- Inadvertent mixing of treatment chemicals
- Unloading chemicals into the wrong tank
- Overpressure leading to safety hazards
- Unknown Hazards

Every list of hazards is incomplete. Unknown hazards have been added to the above list as a reminder there may still be lurking regardless of how exhaustive the research. The team should be encouraged to brain storm hazards specific to the process being studied as part of the what-if.

With the important items specified, we are now ready to generate a streamlined method template for our cooling water system. Create a series of yes or no questions for the team to review and discuss whether or not the expectation is being met. The questions should be concise and not overly prescriptive to allow for discussion. Should the team have questions, refer them to the RAGAGEP from which the question was derived and encourage them to make recommendations to meet the RAGAGEP if a deficiency is discovered. A comments column can be a helpful addition for the team to document deviations where no recommendation is required (e.g. a corrective action is already in progress to address the deficiency, or the consideration is not applicable). An example of a reliability checklist for our cooling water system might look like table-1 below.

Table 1 – An example of reliability considerations for a cooling water system.

CONSIDERATIONS	RESPONSE	RECOMMENDATION	COMMENTS
1. Is there a program in place to regularly measure chemical levels and address deviations in the cooling water system?	Yes		
2. Is there a program in place to regularly inspect and maintain equipment in the cooling water system?	Yes		
3. Is there sufficient redundancy in the cooling water system to maintain desired reliability? (e.g. back up pumps, make up water, reserve tanks)	No	Install an additional cooling water pump with logic to turn on the spare pump if flow from the in-service pump stops.	
4. Is the max head pressure of the cooling water pump(s) less than the MAWP of downstream equipment?	Yes		
5. If the previous answer is no, are there adequate relief devices to protect cooling water and distribution equipment from overpressure due to blocked flow?	N/A		
6. Are there adequate relief devices to protect cooling water and distribution equipment from overpressure due to blocked in thermal expansion?	N/A		There is not a means to block in cooling water distribution and return lines.

The hazard portion will involve placing our identified hazards into a what-if template and allowing the team to brainstorm causes and consequences for the process being studied. The scenario can be risk ranked using a risk matrix. Safeguards are then applied to ensure the risks are sufficiently addressed and recommendations can made to address gaps. This exercise can be as qualitative as a HAZOP, or more quantitative like LOPA. See the example below in table-2. Note that a question has been added at the end to capture some of the unknown hazards. The team in this example identified a hazard around hose rupture while unloading the truck that they identified from experiences working in the process.

Table 2 – An example of a structured what-if Study for common hazards in a cooling water system

What If	Cause/Consequence	Unmitigated Risk			Safeguards (What If)		Mitigated Risk		Recommendations (What If)		Residual Risk	
		S	F	R	Description	RRF	F	R	Description	RRF	F	R
1. Personnel were exposure to treatment chemicals?	1. Leaking flanges in acid line > personnel exposure to leaking acid > single recordable injury	D	5	MH	1. None		5	MH	1. Remove flanges from acid piping to remove risk of leaks from flanges	2	3	L
2. A reaction occurs between treatment chemicals that have been inadvertently mixed?	1. Failure of metering control system > excessive flow of pH control chemicals into tower basin > dilute chemicals mix in basin > waste of cooling water chemicals but no safety or environmental impact											
3. The wrong chemical was unloaded into a chemical tank?	1. Acid unloaded into caustic tank (or vice versa) > violent chemical reaction > overpressure tank > catastrophic failure > personnel exposure to hazardous chemicals > single fatality	B	4	H	2. Vents on chemical storage tanks are large enough to vent pressure from reaction or rapid filling and can allow air to prevent vacuum conditions	2	1	L			1	L
					3. Independent operator checks connection for driver before unloading can begin	1						
	2. Acid unloaded into caustic tank (or vice versa) > violent chemical reaction > overpressure tank > catastrophic failure > acid release to environment > environmental permit violation	D	4	M	2. Vents on chemical storage tanks are large enough to vent pressure from reaction or rapid filling and can allow air to prevent vacuum conditions	2	2	N			2	N

What If	Cause/Consequence	Unmitigated Risk			Safeguards (What If)		Mitigated Risk		Recommendations (What If)		Residual Risk	
		S	F	R	Description	RRF	F	R	Description	RRF	F	R
4. Pressure events caused a safety hazard?	1. Chemical tanks loaded too quickly > overpressure tank > catastrophic failure > personnel exposure to chemicals > single fatality	B	4	H	2. Vents on chemical storage tanks are large enough to vent pressure from reaction or rapid filling and can allow air to prevent vacuum conditions	2	2	M	2. Add a pressure interlock on the chemical storage tanks that will close a valve on the loading line to prevent overpressure	1	1	L
	2. Rapid cooling during weather events > vacuum conditions in tank > damage to tank with causing loss of containment > personnel exposure to chemicals > single lost time injury	C	4	MH	2. Vents on chemical storage tanks are large enough to vent pressure from reaction or rapid filling and can allow air to prevent vacuum conditions	2	2	L			2	L
5. Are there hazards associated with the treatment and distribution of cooling water that have not been addressed?	1. Truck unloading hose rupture > personnel exposure to acid spray > single lost time injury	C	3	M			3	M	3. Require personnel in the unloading area to wear full acid suit PPE	1	2	L

5 Implement the Method into the PHA Program

The streamline method can be repeated for each eligible utility and ancillary process where it is a good fit. The last step is to ensure the effort of creating them is not wasted. The use of the streamlined method should be mandated by the PHA practice where desired. Adding the Checklist and What-if to the template used for PHAs will make it easier to comply when practices and programs require its use. Future PSM audits and assessments should know to look for the streamlined method to ensure it is being used as intended.

Most importantly, the template should remain a living document. Teams should be asked to provide feedback to improve the content, so it aligns better with goals to increase reliability and safety. Perhaps some of the previously unknown hazards can be added to the template so they are no longer unknown. Finally, a person should be assigned responsibility for the program and should conduct periodic reviews on the streamline method to add or remove safety concerns or reliability practices as the process evolves.

6 Conclusion

Implementing the streamlined method at Nutrien has taken the days long PHAs for utility and ancillary systems and reduced them to less than 4 hours. Comparing the risks identified by a HAZOP team with a team using the streamline method found that while the HAZOP team discovered more causes that led to certain consequences, both teams found almost the same number of unique risks. In other words, a specific consequence may have a dozen causes, but because the risk of that consequence is a factor of the frequency of the most likely cause, identifying additional, less frequent causes does not necessarily change the risk. Assuming the most likely cause is identified, the overall risk remains the same. The edge cases, where this is not true, can be addressed by performing a more comprehensive study, like LOPA, on high risk scenarios, which many programs require anyway.

The streamline method for utilities and ancillaries can provide faster, quality risk identification if one is willing to make the initial effort to gather applicable RAGAGEP and hazard information to create a streamline method and add it to their PHA arsenal.