Assimilating Design Formulation and Design Review into a HAZOP

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Abstract

There have been numerous guidebooks written for the application of Hazard and Operability (HAZOP) Studies[1] to operating facilities and capital projects where the design is relatively mature. For these systems, critical process safety information is typically available, but for fast-moving capital projects that is often not the case, and in addition there are often many contrasting issues:

- Design flexibility allows for more extensive changes at early stages of the project. Even the ability to cost-effectively make larger numbers of smaller changes can have a measureable improvement in safety and decreased operational risk.
- Less-detailed design information at early stages of the project can result in an incomplete safety assessment resulting in re-work and re-HAZOP.
- Late design changes can have a more significant impact on project schedule later in the project cycle.
- With the proper focus, designers can often benefit from feedback obtained from owner-operator personnel and from the thought process invoked by the HAZOP approach.

These issues represent fundamental contrasting priorities. Although applying a designed-to-be-detailed analysis tool like HAZOP at early stages of the project is a fundamental challenge and presents many dilemmas to the HAZOP Study Facilitator, the application of a phased approach can help achieve the true objectives of the HAZOP Study, which is to make as many safety improvements as practical to minimize risk.

The "double-edge sword" is by incorporating HAZOP Study approaches early in the design process, important safety improvements can be done more cost-effectively, allowing limited project funds to have a greater impact in lowering net risk, but it may require some "re-visiting" of the HAZOP Study. The alternative (doing a final HAZOP Study, after all of the design work

is complete) obviates the need for any re-assessment of safety issues, but it also eliminates the practical ability to implement any design changes, unless the risk is very high. Thus, if carefully managed, the introduction of HAZOP concepts early in the design cycle, evolving the level-of-detail with design maturity, and the performance of focused updates to the HAZOP Study, can be used to most cost-effectively minimize the risk associated with the project design. This approach can also be used to minimize last-minute design changes that could have had the potential to greatly increase project costs and result in project delays.

This paper will examine the use of the HAZOP approach during the design cycle and introduce mechanisms to make this Design HAZOP (D-HAZOP) meaningful as a decision-making and technical problem-solving tool that can be used to accent the Design Formulation and Design Review process.

Our objective is to assist the reader with practical tips to communicate these concepts to the technical community and capital project management – to facilitate a shift in paradigm that uses HAZOP in a new way that provides for safer process facilities, while likely streamlining project schedules and budgets. D-HAZOP then is not perceived as a project impediment, but as support of critical capital project goals and objectives.

1. Introduction – Challenges and Benefits of Incorporation of Hazard and Operability (HAZOP) Study Concepts into the Design Process

1.1 Application of HAZOP to Operating Facilities and Facilities Under Design

The Hazard and Operability (HAZOP) Study technique was originally designed to be a detailed evaluation for a completed plant design (e.g., completion typically accomplished through a design formulation and design review process) or constructed/operating facility. Many of the early HAZOP Study applications were focused on high-hazard facilities. Application of HAZOP has had a positive impact on establishing a culture, which considers potential hazards, and the need for reliable, and often independent, safety systems. Many of the safety best practices for design engineers today have arisen through an evolution of concepts derived through HAZOP, exposure of design engineers and operations superintendents to HAZOP Studies and related activities. The application of HAZOP Studies has (slowly) fundamentally changed how designers approach a design – to not solely focus on functionality for operational performance objectives, but also safety, and more specifically, ensuring that the design is robust in dealing with upset conditions and potential hazards.

- Employee Participation
- Process Safety Information
- Process Hazard Analysis
- Operating Procedures
- Training
- Contractors
- Pre-Startup Safety Review
- Mechanical Integrity
- Hot Work Permit
- Management of Change
- Incident Investigation
- Emergency Planning & Response
- Compliance Audits

FIGURE 1.1 – Key PSM Elements

Especially with the increased use of packaged units by Engineering Contractors, HAZOP Studies can be an essential part of the design process.

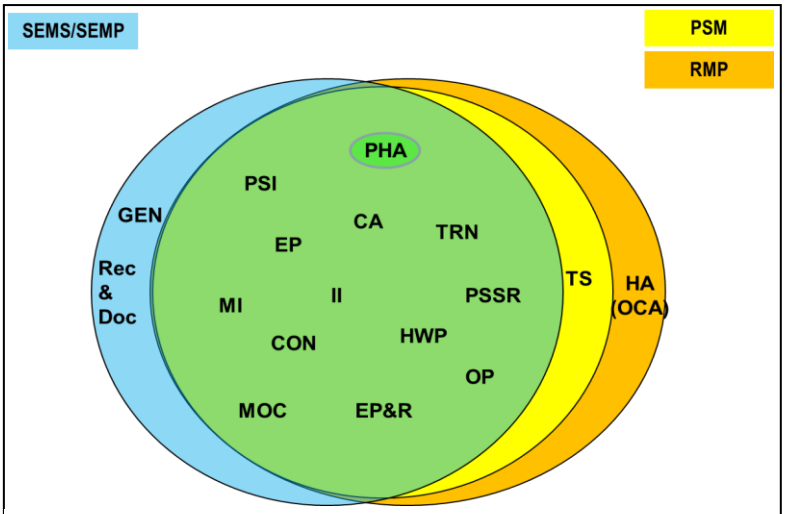

FIGURE 1.2 – Overlap Between Key SMS Programs

The broader application of HAZOP that began in the 1990s precipitated from tragedies that occurred in the 1980s, through recognition that establishment of a high level of process safety was a technical management issue[2,3]. These HAZOP Study applications focused on operating facilities and were designed to identify potential vulnerabilities that could translate into fatalities, injuries, and/or severe damage to the facility.

The application of HAZOP was also driven by United States regulatory requirements (Process Safety Management (PSM)[4] and Risk Management Programs (RMPs)[5]), as well as Safety Cases[6], which had broader application outside the United States. Figure 1.1 illustrates the fundamental role that Process Hazard Analysis (PHA) plays in PSM, and Figure 1.2 illustrates the commonality of key process safety elements for PSM, RMP, and Safety & Environmental Management Systems (SEMS)[7], of which PHA is foundational to all of these programs. Without the design information that provides a basis for the evaluation, and without using PHA to understand the hazards and operability issues that need to be controlled, the foundation for these Safety Management Systems (SMS) would crumble. Understanding hazard and operability issues is fundamental to the successful implementation of the broader range of SMS programs.

Figure 1.3 – Tragedies to Avoid

<u>Given the fundamental importance of PHA to plant safety and operability, the question isn't should it play a role during the design process, but how can the design process be effective and efficient without it?</u>

Although tools like HAZOP must be used to address critical regulatory requirements and to work towards the elimination of undesirable events (Figure 1.3), in our focus on meeting these important objectives at the end of the design process, it is sometimes easy to not see other applications for this powerful design evaluation tool.

The focus of this paper is the exploration of these other capabilities of the HAZOP concept and its utilization during the design process. Use of HAZOP as a decision-making and technical problem-solving mechanism encompasses the original functionality and format of HAZOP, but is structured for increased functionality and flexibility in Design HAZOP (D-HAZOP). The sensible infusion of D-HAZOP decision-making and technical problem-solving capabilities directly into the design process achieves additional, substantial benefits beyond its primary purpose of identifying potential design vulnerabilities that could precipitate potential hazards or operability problems, such as:

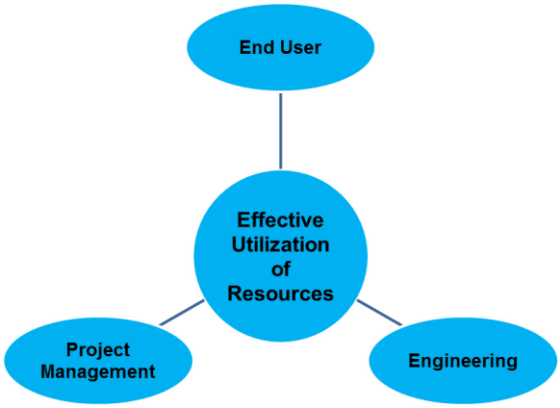

Figure 1.4 – D-HAZOP – Effective Utilization of Resources to Support Project Control Objectives

- More flexibility in addressing fundamental safety issues, especially Inherently Safer Design (ISD)[8] by infusing hazard evaluation directly into the design process
- Benefits to budget and schedule through more effective utilization of resources (Figure 1.4)
- Reduced Project Costs

1.2 Addressing Project Objectives

Table 1.1 and Table 1.2 contrast responsibilities that are more in the domain of Project Engineering and those that are more in the domain of Project Management. Although, at first glance, a significant overlap does not appear to exist, these responsibilities and project objectives are not mutually exclusive. If HAZOP Studies are explicitly folded into the design process through the D-HAZOP approach, and interactively, D-HAZOP becomes more of a decision-making and problem-solving tool (consistent with its nature), it can open the door to significant benefits that help both Project Management and Project

TABLE 1.1 RESPONSIBILITIES MORE IN THE DOMAIN OF PROJECT ENGINEERING
Solving Challenging Technical Problems
Maximizing Operability
Optimizing Efficiency
Safety

TABLE 1.2 RESPONSIBILITIES MORE IN THE DOMAIN OF PROJECT MANAGEMENT
Budget
Schedule
Safety

Engineering meet their objectives.

An important focus of this paper is sharing tips on achieving these benefits and illustrating the ability of teamwork to solve problems and make decisions.

Although Safety is on everyone's list, D-HAZOP is a platform that can address key project objectives for all stakeholders!

2. D-HAZOP as a Decision-Making and Technical Problem-Solving Tool

The Hazard and Operability (HAZOP) Study was originally crafted as a brainstorming mechanism for thoroughly identifying potential hazard and operability problems for an operating or completely-designed facility.

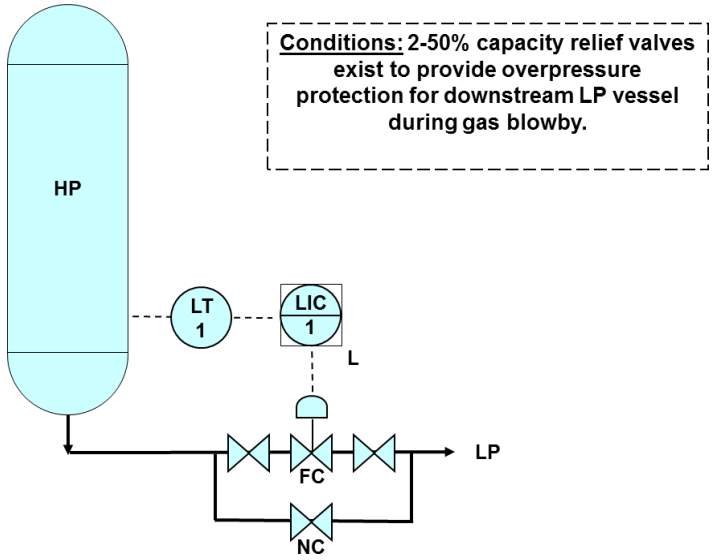

Figure 2.1 – Simple HAZOP Study Example

HAZOP is a tool designed to utilize basic design functional information (example in Figure 2.1) to feed into a brainstorming process that pivots on the use of a "deviation matrix" (Table 2.2) that is designed to help the team focus on general process issues. A cyclic approach (Figure 2.2) is designed to add further structure to the activity for the development of scenarios that reflect important things that can go wrong. These scenarios are often documented in a tabular form to summarize critical ways that a system can fail. It is this transformation from a "how does the system function" perspective to a "how can it fail perspective" that makes the HAZOP approach valuable for identifying potential weakness in design or operations. It is this same strategy that makes the concept useful throughout the design process. It is important that the D-HAZOP approach is applied such that it should not dilute its objectivity in evaluating potential hazard and operability issues.

When considering the use of HAZOP to identify hazard or operability vulnerabilities to resolve issues during the design process, one should really not ask "Is it a good idea?" but "Why would anyone not want to infuse a mechanism to resolve problems into the design process?".

TABLE 2.1 – TIPS

D-HAZOP is a Decision-Making and Technical Problem-Solving Tool

Use D-HAZOP as a Decision-Making Platform throughout the Design Process

DESIGN/ OPERATIONS PARAMETER	GUIDE WORDS					
	No/Low	**More/ High**	**Misdirected**	**Reverse**	**As Well As**	**Other Than**
Flow	No/Low Flow	More Flow	Misdirected Flow	Back Flow	Contam-inants	Wrong Material
Temperature	Lower Temp.	Higher Temp.				
Pressure	Lower Pressure	Higher Pressure				
Level	No/Lower Level	Higher Level				
Other/ General	Composition, Maintenance, Start-up/Shutdown, Heat Tracing, Piping Specifications, Phase, Viscosity, Density, Reaction, Corrosion, Erosion/Fatigue, Sampling, Service Loss, Duration, Sequence, Human Factors, Safety/Health, Instrumentation, Agitation, Speed					

Table 2.2 – HAZOP Study Deviation Matrix

Since it is intended to resolve hazard and operability issues and provide a framework for making difficult decisions, the concept is very well-suited to the design process. The same fundamental strategies can be used throughout the design formulation and detailed design process as a decision-making and technical problem solving tool, with creative adjustments on its use. These adjustments and this application are referred to as a D-HAZOP (See Table 2.2). In later sections, some of the adjustments made to the core HAZOP approach to achieve practical D-HAZOP objectives are explored. First, however, portions of the design and construction process

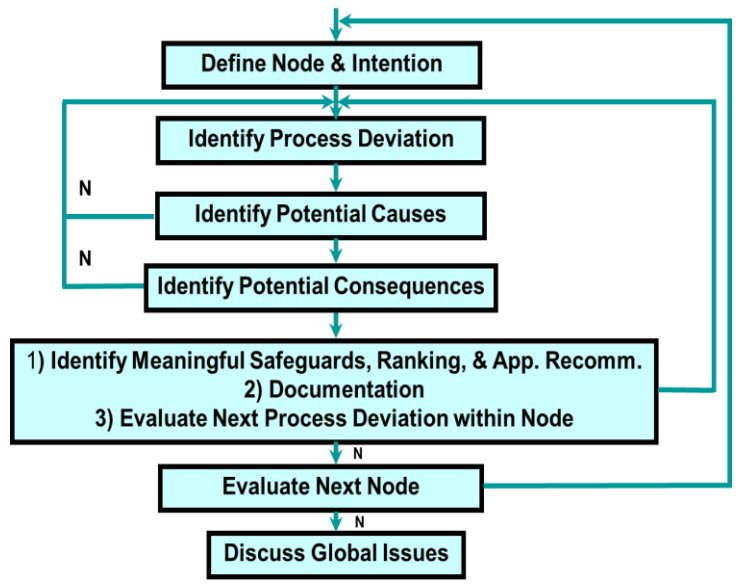

Figure 2.2 – General HAZOP Flow Chart

that may be suitable for using a D-HAZOP are examined.

3. Practical Integration of D-HAZOP Concepts into the Project Timeline

Just like a carpenter's toolbox is full of tools that may have a specific application, HAZOP techniques have different uses at different stages of facility life. Figure 3.1 illustrates the types of tools that are useful to uncovering relevant potential hazard and operability issues.

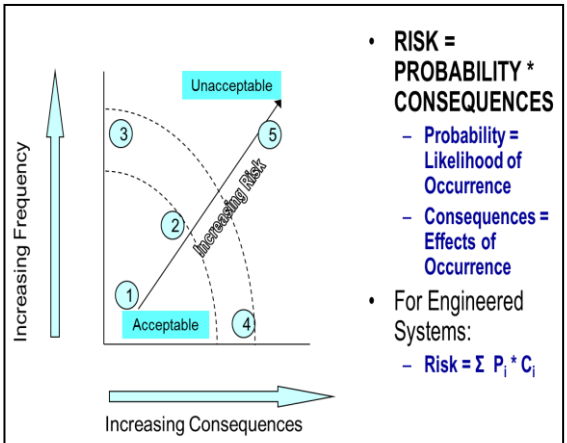

FIGURE 3.1 – Putting Design Challenges into Perspective

In general, at early stages of facility life the HAZOP tool may not be very helpful, since critical issues associated with the design intent and project scope must be formulated. As the design process begins to take shape, "high level tools" like Hazard Identification (HAZID) may be used to identify critical siting issues or to investigate important Inherently Safe Design (ISD) issues (Reference 5). Similarly, during the construction and commissioning phases of a project, the design efforts have been completed and the hazards evaluations more take the shape of Job Safety Analyses (JSAs). During operation, there may be periodic need for JSAs and occasional application of various PHA techniques, especially if needed to address Management of Change (MOC) issues and regulatory requirements[4,5].

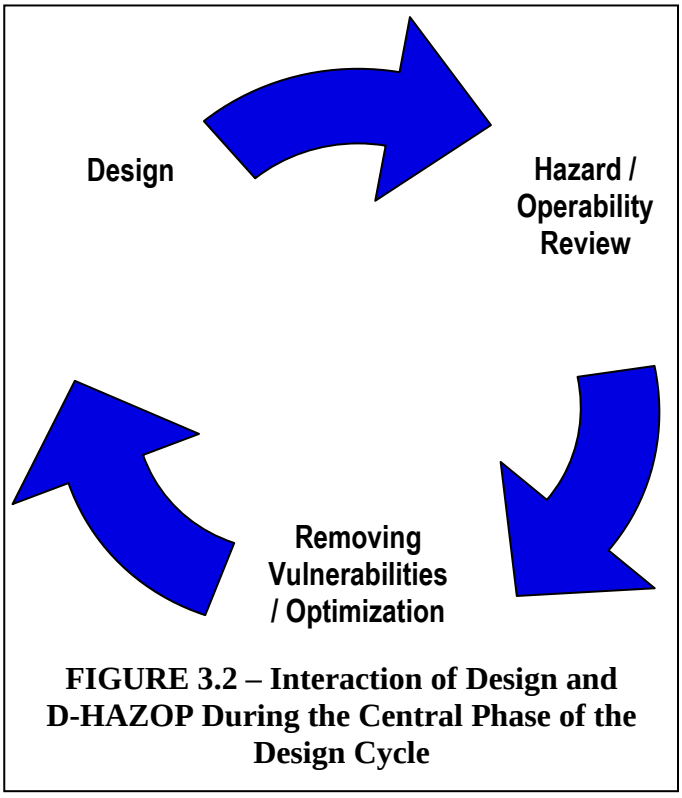

FIGURE 3.2 – Interaction of Design and D-HAZOP During the Central Phase of the Design Cycle

The Conceptual and Detailed Design phases are periods of time where the application of interactive D-HAZOP can be the most beneficial. The ability to:

- Identify potential vulnerabilities
- Resolve design issues
- Balance hazard and operability issues

makes the activation of a platform to bring stakeholders together to identify and resolve issues all the more important.

The next section details the critical individuals and resources that are useful to accomplish these objectives for the central design phase for the project.

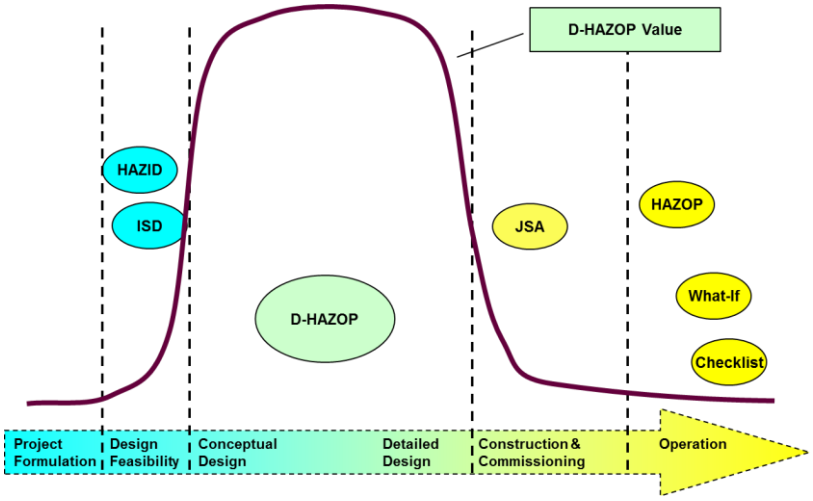

Figure 3.3 – Hazard/Operability Decision-Making Tools in the Facility Life Cycle

4. Resources – Team Composition

It is important to recognize that in addition to it being an independent safety evaluation, a HAZOP Study is a technical problem-solving and decision-making exercise that is fundamental to making progress on the engineering project. Another critical element in making progress is the quality of the resources (i.e., design/safety information and personnel) available to the HAZOP Study. Since unlimited attendance is not practical, it is important to understand the technical resources needed for technical problem-solving and decision-making for heavy industry processes.

Table 4.1
Key Disciplines Useful for a Design Formulation & Design Review Team

- Facilitation/Leadership
- Process Engineering
- Control/Protection Systems Engineering
- Health, Safety, and Environmental (HSE) Engineering
- Operations

Table 4.2
Key Disciplines Useful for a HAZOP Team

- Facilitation/Leadership
- Process Engineering
- Control/Protection Systems Engineering
- HSE Engineering
- Package Vendor Representation
- Rotating Equipment Specialists
- Operations

It is possible to note some similarities between the important disciplines useful for a Design Team and for a HAZOP Team (Table 4.1 and Table 4.2). From experience, the types of

individuals who make primary team contributions to both of these efforts is a point of continuity. The important things to recognize are:

- Size
- Capabilities
- Dynamics

The investment in resources aligned to a Design Team and to a HAZOP Team is significant. Although an important difference is that Design Teams are often not doing the majority of their work over a conference table, the need to interact and the benefits associated with this interaction uses the same underlying concept as for the choice of team members for a HAZOP. In addition, the number of people assigned to each of the critical disciplines represents a staggering investment. Channeling these resources and energies can yield significant benefits, and rapid feedback can result in being able to utilize these insights much more quickly.

Figure 4.1 – Working with a Design Team and a HAZOP Study Team can be Similar Experiences

HAZOP is very much about energizing a forum for problem-solving and decision-making. Not making full use of these resources during the full design phase of the project is missing out on an important opportunity.

The best applications use this feedback loop to resolve issues more quickly and avoid "11th hour" surprises that could occur if the HAZOP is finished after all of the detailed engineering work is done and can result in significant scheduler and budgetary impacts.

A critical question is, what drives the structuring of projects, such that the safety review is delayed to the end of the project? Although a partial understanding can be achieved by recognizing that safety reviews can be more thorough if done when everything is finalized, this approach can be self-defeating. By focusing the HAZOP as a problem-solving process, the team can:

- use their capabilities to have more useful input into the design
- avoid last-minute complications
- have a much greater feeling that they are actively contributing to facility safety

Having a platform to interactively resolve critical issues during the design phase of a project is supportive of maintaining schedule and budget. Use of a HAZOP Study platform to support these objectives is conducive to satisfying both project management and engineering objectives for the project.

5. Handling Typical Challenges (technical, people, information)

To achieve the critical objectives (identified in previous sections) during a review that is continuously morphing, the facilitator must address a number of challenges associated with:

- Information availability/completeness
- Information maturity
- Information accuracy
- Availability of busy individuals with other responsibilities (geographic limitations may also represent a logistical challenge) – In all cases, it is critical to make exceptionally good use of people's time.
- Management pressure to avoid changes and associated project impacts

Facets of these challenges are pertinent for all HAZOP Studies, but they can be critical for application of the technique during the design phase – especially if utilizing HAZOP as a broad-spectrum design evaluation tool.

The following represents some specific challenges and tips on handling them:

- **Prioritizing Conclusions Needed for Critical Design Issues** – A good HAZOP Study documentation method is to use a highly consistent approach to structuring the order of process deviations, where specific equipment failures are addressed (e.g., an emergency vent failing open could be categorized as a More Flow or Misdirected Flow event … be consistent), and level of detail. This provides the HAZOP facilitator with the ability to pre-load critical equipment failures, and to work in unison with the team and to more efficiently follow (i.e., bounce around) important issues to capture critical insights as they are brought up or to skip items and only address key scenarios. For a rapidly moving design effort, this allows important insights to be brought out early (especially useful if they have an impact on design) and fed to the Design Team. This is especially useful if the Design Team members not participating in the HAZOP can resolve critical issues in parallel to the HAZOP and allow convergence before the HAZOP is done and the team disperses. This can facilitate resolution.

Figure 5.1 – A Key to Success for a Design HAZOP is for the Design and Safety Evaluation Level of Detail to Synchronize

- **Prioritizing High Risk Scenarios** – If the HAZOP facilitator uses his/her engineering background to select scenarios that may identify worthwhile design options or high risk

scenarios, critical feedback that may have an impact on capital costs and project schedule can materialize sooner and have the best, positive impact.

- **Completeness Concerns from the HAZOP Study Team** – Many of the participants in a broad-spectrum HAZOP Study may be much more accustomed to a more traditional setting, where all design information is complete and operational parameters known. From Owner-Operator Company representatives, it is not uncommon to hear comments that their company does not allow a HAZOP Study to be done unless all of the design, operations, and maintenance information has be gathered and verified as suitable for HAZOP. There are also cases where the discomfort level is sufficiently high such that people will walk out. There are ways of handling this:
  - As a professional, you have to agree with them that a safety evaluation like a HAZOP should never be compromised.
  - Create some mechanism (e.g., a specific HAZOP recommendation) that provides a trigger point for ensuring that this area of the process is re-HAZOP'd after the design is updated.

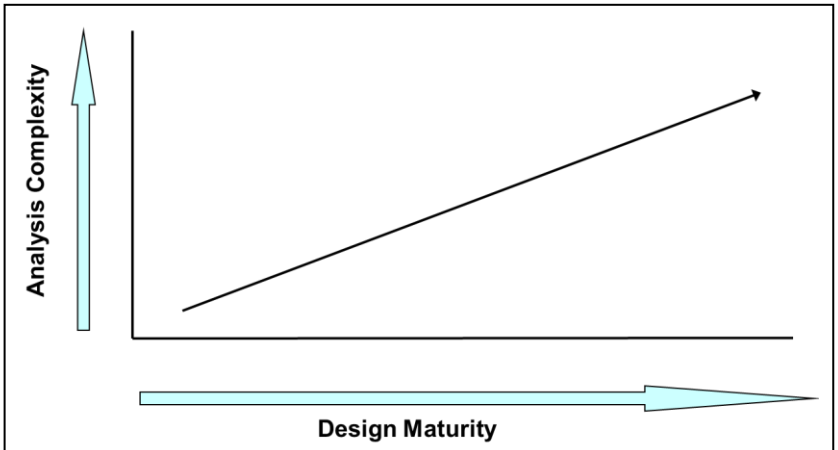

Figure 5.2 – Match Analysis Depth to Design Maturity

  - Emphasize to them that the Design Team needs the results of the HAZOP to proceed to the next step efficiently, and the project needs the feedback from the HAZOP to efficiently make potentially capital-intensive changes that will result in safer operations.
- **Opportunity to Correct Problems Before Adjourning the HAZOP Study** – For a fast-paced project, the momentum associated with the HAZOP team being together provides an opportunity to resolve issues that support High Value Modifications or resolution of issues quickly. The use of the classic "parking lot" on a flipchart provides an ability (and significant incentive) for a Design Team to assign the non-HAZOP participants the option to dig up missing information or resolve design issues, and report back to the HAZOP team, and make updates as necessary to resolve and close out critical issues.
- **Updating Master Copies of Engineering Drawings During the HAZOP Study** – Although a formal change review is more common, during the design phase of a project, if the Design (typically Process) Engineer assesses that the change is a High Value Modification and likely to be implemented, showing the change to the team and making any suitable change to the HAZOP is a great way to streamline effort, avoid a re-HAZOP, and keep the project on-track. This can typically be done with approximately half of the changes. Of course, if (later) the change is determined to be inappropriate, it can always be changed back.

- **Simultaneous LOPA** – For high risk scenarios, those involving Safety Instrumented Systems (SIS) as safeguards, or one that require LOPA for some other reason; performing an initial LOPA calculation with the team accomplishes several things:
  - **Streamlining Changes** – During-the-session LOPA (especially for Safety Integrity Level (SIL) Allocation Targets) allows for rapid feedback to the Process and Instrumentation Design engineers to evaluate critical design options, and as appropriate present them to the team for additional feedback/convergence. This approach can help keep the project moving for even the toughest challenges.
  - **Quality** – Carefully described scenarios that allow the assessment of scenario likelihood can directly improve the quality of the hazard identification exercise. Sometimes just discussing the scenario yields additional insights. At other times, when there is a wide gap between the HAZOP Study risk-ranking and the LOPA results, it provides a good catalyst for discussion that usually demonstrates that one of the assessments was erroneous.
  - **Training** – LOPA is tool that is not often used. Training the participants on appropriate applications is critical.
- **HAZOP Study Pre-Work** – There are still HAZOP practitioners that might argue that the facilitator should show up at the study with a blank sheet of paper and work out the nodes and everything else with the team. The same individuals might also argue that the facilitator shouldn't have any knowledge of the process or have reviewed the engineering drawings before the HAZOP. That perspective is not shared here. The best approach is for the Facilitator to be objective, and familiar with the process, but not be a direct stakeholder, which might compromise objectivity. Although the HAZOP team needs to be given time to think through critical scenarios and brainstorm new ones, the facilitator should guide the team, and pre-work (e.g., node and important cause definition) can be very helpful, typically appreciated, and can enhance the quality of the HAZOP. With a little pre-work, the Team is able to focus on complexities and brainstorm new issues, rather than being "burned-out" on trivial items. In the same manner, for a fast-track design effort, where the results of the HAZOP for high risk scenarios can be immediately fed into the design, some pre-work to carve out a starting point for any needed Layer of Protection Analysis (LOPA) can also serve to resolve critical design issues and verify that there are no "show-stoppers" in advance of the HAZOP team's efforts, thus potentially streamlining both their efforts and any iterations on the project.

6. Infusing Insights from Owner-Operator Personnel

During the Design Phase of a project, with the focus on engineering, input from owner-operator personnel is rarely utilized. In some cases, engineers may not appreciate the value of insights from personnel who have worked with similar processes. Most often, the issue is more one of not having a good mechanism to secure and utilize those insights. During the Design Phase, the depth of technical discussions and types of specialized, computer-intensive tools utilized (e.g., CAD, process engineering software) often defy interface with the boots-on-the-ground knowledge base of owner-operator personnel. In many cases, these tools and the mechanisms for

which designers work together compromise involvement by owner-operator personnel, thus, excluding a very important resource.

Application of these insights can:

- Save time
- Focus design energies
- Avoid rework
- Conserve project budget

It is clear that it is undesirable to wait until the design is completely done to start utilizing these insights (i.e., resources):

- Get the owner-operator team involved early in the design process to vet the design and the way the systems will be operated
- Infuse operations issues early in the design so that the design meets the needs of the end-user.

The general HAZOP approach is a mechanism for circumventing the natural barriers between design engineers and owner-operator personnel, which provides this forum for reaping the above benefits and infusing needed information from owner-operator personnel. The interactive approach associated with a D-HAZOP is a mechanism for doing this throughout the entire design process.

Table 6.1
Types of Insights Available from Owner-Operator Personnel

- Equipment consistency with operating company "norms" – If the operating company has certain vendors, types of equipment, etc., it can often be a savings of time to the design engineer, budget for the project, and improvement in customer satisfaction just to use it.
- Equipment accessibility issues
- Types of tools used/available
- Typical operations practices
- Levels of training
- Acceptable types of emergency warning systems (audible and visual)
- "Norms" for Emergency Shutdown (ESD) activation
- Emergency response resources
- "Norms" for evacuation and assembly
- General practices for heavy equipment movement in process areas

Some additional tips:

- For the Design Engineer, owner-operator personnel insights can be very helpful, but if not properly vetted, they can also detract from the focus of the design. Especially dangerous is the use of individual "opinions," rather than substantial directives. These can often be subjective and subject to change (understatement). Thus, it is fair (and often appropriate) for the design engineer to "challenge" feedback from individuals about company "norms," when there

really may be multiple design options. As part of this "challenge," it is definitely fair to request confirmation formally, i.e., in writing, so it doesn't change the next time that someone else offers an "opinion". It is fair to ask that Operations take "ownership" for resolution and finalization for any of these areas where different options exist.

- Many times operations personnel, during the D-HAZOP, identify issues that may be more suitable for review and discussion, and are more efficiently addressed, as part of a 3-D Model Review. It may be appropriate to defer these items to the 3-D Model Review.

7. Pitfalls and Cautions

Working with a "moving target" can present a lot of challenges to the D-HAZOP facilitator. In this section are provided tips on handling problems and when to "STOP."

Previous sections have discussed the use of D-HAZOP as a technical problem-solving and decision-making tool for the design phase of a project. In addition, an important objective is for the evaluation to evolve into eventually becoming the final/formal HAZOP Study that is synchronized with the design and can be handed over to the operating facility as part of the turnover package. The whole exercise, with application of D-HAZOP during the design and working towards a quality HAZOP that can be provided in the turnover package, is about providing value and achieving critical project objectives.

Figure 7.1 – Avoid Exceeding Information Limits when Applying D-HAZOP

A perennial challenge when attempting to provide value as part of the D-HAZOP is dealing with incomplete information. By nature, the design is not finalized; that is why the D-HAZOP is a useful exercise to pick up important design improvements when they can most effectively be implemented. As part of the exercise, it is important to push the team to the limits of their knowledge, but there are limits. It is important to solve what can be solved, but to also know when to stop because value is no longer being provided.

During the D-HAZOP, it is time to stop the team exercise associated with that portion being evaluated when:

- The team can no longer provide value in terms of design decision-making
- Information is sufficiently unavailable such that there are no clear conclusions that can be reached by the team

If the above trigger points mandate the D-HAZOP be stopped, this is important, and you should not hesitate. If it is necessary to stop, recognize the impact on personnel productivity. It is also important for there to be some mechanism that will trigger follow-through or closure of that area of the process at a later date. The closure point can be to simply pick up later, where the team left off. Alternatively, it may be possible for the team to add value by outlining the decision-making criteria (and critical actions) to enable the designer to have a clear path forward, which will enable him/her to complete the design, which of course would later be validated through the D-HAZOP process.

Although pushing the limits may sometimes be uncomfortable (people are obviously more in their comfort zone when the design is complete, and they are part of a HAZOP that methodically investigates each-and-every possible deviation), the potential to have more options to significantly impact the hazard and operability characteristics of the facility under design is a tremendous opportunity.

The design is a moving target during the initial design phases, and a critical issue is effectively handling the situation as the design matures. Management of Change (MOC) has its origin in 1980's best practices documents for managing safety via the control of design and operational configurations of high-hazard process facilities. The term "Configuration Control" had also been a popular concept that preceded MOC. Regardless of the term, the concept was well-targeted for operating facilities, where changes should be well defined and finite. In an effort to manage safety aspects of design projects, during the 1990's, it began to be applied by Engineering and Construction (EC) companies.

Figure 7.2 – Use D-HAZOP to Avoid Getting Wrapped Around the Axle with MOC

The concept of MOC is important; however, if applied too early for a rapidly evolving design, it can result in significant increases in work with minimal value-added. The way that MOC is implemented can result in the need for multiple levels of signoff for every little change. This can literally have a project "wrapped around the axle" with respect to disabling the ability to affect improvements to the design. If this discouraging effect and management costs associated with affecting improvements to the design are preclusive [to the point where even a design simplification that has a minor positive impact on safety cannot be implemented because of the large cost of the change (primarily management and overhead)], it is rational to question the merits of applying MOC.

One alternative is to more broadly apply D-HAZOP during the design process to enable safety evaluations to evolve in lock-step with the design. If this application of D-HAZOP is properly managed, the MOC "black hole" and its potential for impeding improvements to facility safety and operability can be avoided. In this way, the need for change is recognized in the project planning phase and a mechanism is applied to more efficiently deal with change. Issues pertinent to the D-HAZOP can be bundled and effectively addressed with periodic reconvening of the primary resources that contributed to the D-HAZOP.

8. Creating a Safer and More Operable Facility, while Reducing Project Costs and Maintaining Schedule

Unfortunately, the application of HAZOP has often fallen short of being an exciting adventure that people look forward to. In addition, due to poor implementation, HAZOP Studies have in many cases also fallen short of doing a good job evaluating safety and operability issues. For that reason, managers of projects who are responsible for the implementation of the design effort sometimes viewed the application of HAZOP-type approaches somewhat unfavorably.

For this reason, there is often resistance to the level of implementation that could allow fruition of higher level applications of these techniques. With proper leadership and technical resources, the D-HAZOP approach can be used effectively in the decision-making and technical problem-solving framework, and it is possible to shift the paradigm of how it can be used for:

- Project control
  - Forces engineers and other team members to complete their efforts so that they are suitable for sharing
  - Forces resolution of information bottlenecks
  - Drives the D-HAZOP participant to think beyond the structured keyword approach and anticipate what can be lacking in the design that may result in unforeseen hazards
  - Neutralizes the "I'm waiting for …" syndrome
- Maintaining project schedules
- Maintaining project budget
- Teamwork – providing a forum for resolving design disputes between the owner-operator and the designer that doesn't require continuous escalation to project management

9. References

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