Hazard and Operability study (HAZOP) Guidance for fertilizer industry

Document Development Guidance
Department: Process Safety
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1. SYNOPSIS

AmmoniaKnowHow.com and UreaKnowHow.com support fertilizer manufacturers by providing essential services to the industry, using our syngas technologies and scientific knowledge developed in multiple projects worldwide.

Together we initiate a program to enhance the guidelines and procedures for operation, engineering, maintenance and process safety in the fertilizer industry utilizing the best practices and standards available today.

Using knowledge gained from our industry, historic risk registers, lessons learned from projects and from FIORDA members we are committed to give proper advice to improve safety, reliability and projects performance of fertilizer plants.
2. WHY DEVELOP SPECIFIC GUIDELINES AND PROCEDURES

Guidelines and Procedures are developed to help staff and management teams run the organization. In the best use situations, procedures play a strategic role in an organization. They are developed in light of the mission and objectives of the company and they become the media by which management’s plans, rules, intents, and business and operation processes become documented and communicated to all staff.

Carefully drafted and standardized guidelines and procedures save the company countless hours of management time. Guidelines, procedures and employee handbook should be an important part of the operation. They should be the first thing given to a new employee (either in hard copy or an electronic version). They should also be easily accessible in their most up-to-date version. Hence it is extremely important that an organization’s procedures are a “living document” prepared and saved in Microsoft Word and easily exported into portable versions (like PDF) and made available over the company network.

3. PURPOSE OF THIS DOCUMENT

This document shall provide guidance to personnel carrying out Hazard and Operability (HAZOP) studies, within projects or operating facilities in the fertilizer industry.

This document defines the scope of a HAZOP study, identifies the requirements for conducting studies and identifies situations for which studies may be appropriate.

4. HAZOP DEFINITION

HAZOP – An abbreviated term for a hazard and operability study. It is one of a number of structured hazard identification and analysis tools in which system parts are individually and methodically examined using a guideword approach and the effect of deviations from the design intent identified. When a hazard and operability issue is identified, appropriate actions are recorded in order to address the area of concern.

Features of a HAZOP include:

- Detailed and systematic examination of system parts using guide words.
- Carried out under guidance of a trained and experienced Facilitator responsible to ensure comprehensive coverage of the system under study.
- Includes input from specialists from various disciplines and relevant functions.
- Carried out in a climate of positive thinking and frank discussion.
- Resulting knowledge obtained by identifying potential hazards and operability problems in a structured and systematic manner is of great assistance in determining appropriate remedial measures.
- Developing solutions to identified problems is not the primary objective and is undertaken outside of the HAZOP.
5. HAZOP IN PROJECTS

The HAZOP technique requires an accurate and complete design representation of the system or sequence under examination and as such is more suited to later project phases. During early project phases when the design may be loosely defined alternate techniques for hazard identification should be employed (e.g. SWIFT). Project phase considerations are discussed below.

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Applicability</th>
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<tbody>
<tr>
<td>Identify</td>
<td>Preliminary analysis</td>
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<tr>
<td>Evaluate</td>
<td>Feasibility studies, Conceptual Design</td>
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<tr>
<td>Define</td>
<td>Front End Engineering Design (FEED)</td>
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<tr>
<td>Execute</td>
<td>Detailed Design, EPCM, PMC</td>
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<tr>
<td>Operate</td>
<td>Asset Services, Maintenance, Upgrade, Decommissioning</td>
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6. HAZOP TEAM: ROLES AND RESPONSIBILITIES

This guideline makes reference to the following position titles:

**Project Manager** - The Project Manager is responsible for ensuring the HAZOP requirements are executed on the project in accordance with the Project Execution Plan and appropriately resourced. These responsibilities include appointment of a “HAZOP Coordinator”.

**HAZOP Coordinator** – This is the person in charge of organizing the HAZOP, ensuring that the HAZOP report is circulated, and ensuring that the items are closed out. The HAZOP Coordinator may be the project Lead Safety & Risk Engineer, the location Chief Safety & Risk Engineer or other suitable nominee as designated by the Project Manager.

In many cases, the HAZOP Coordinator will not be the person actually conducting the work, but it is their responsibility to ensure that the required work is carried out.

**HAZOP Facilitator** – The person in charge of running the HAZOP workshop.

The HAZOP facilitator must be on the approved list of HAZOP Facilitators which is maintained on the Safety and Risk Engineering Discipline.

The HAZOP facilitator should not be closely associated with the system/sequence design or delivering the subject of the HAZOP study, as there is a danger of real or perceived conflicts of interest in identification of hazards, operability problems or design flaws, i.e. the HAZOP Facilitator should not be responsible for design or project delivery of the system/sequence under review. An independent person is able to place a more objective viewpoint on the proceedings and study outcome.
The major function of the HAZOP facilitator is to guide the team in the HAZOP process during the HAZOP session. However, the HAZOP facilitator should assist with the defining of objectives for the study, reviewing the HAZOP Charter, choosing team members and adequately preparing for the study. The principal role of the HAZOP facilitator is to ensure a thorough study that adheres to the process, to control the team’s discussions so that time is not wasted and to ensure that workshop discussions are properly recorded.

For most HAZOPs, an experienced technical scribe is preferred as part of the Study Team since they can have a significant impact in terms of efficiency by enabling the facilitator to concentrate on the process and not the records. For large HAZOP’s there may be value in having more than one scribe, using them in rotation to limit fatigue. For small and simple HAZOPs, the facilitator may elect to take on the responsibility of the scribe.

**Attendees** – The team shall be multi-disciplinary and comprise representatives from all groups involved (e.g. design/technology, project, operations and maintenance) and people should be selected for their knowledge of the process and/or equipment and/or ability to make a technical contribution.

The overall composition of the team varies according to the objectives and study area. A team typically contains 6 to 8 people. If the group is too small, there may be insufficient breadth of knowledge to ensure completeness and interaction of ideas and disciplines. If the group is too large, then everyone may not be able to communicate their ideas effectively. An important feature of the team and its members is that they have a positive and constructive attitude towards the study.

- Process Engineer (from design team)
- Piping/ Mechanical Engineer
- Lead Instrumentation & Control Engineer (or delegate as appropriate) from design team
- Control System Supplier Technical Engineer
- Supplier technical specialist (i.e. proprietary equipment)
- Operations Superintendent/ Supervisor (responsible for actual operations of the relevant facility)
- Operations Maintenance Representative
- Instrumentation & Control Engineer (from vendor organization)

**7. THE DIFFERENCE BETWEEN HAZOP AND HAZID STUDIES**

HAZID and Hazard and Operability (HAZOP) studies are different in nature and are carried out at different points in the development of a design.

They are complementary, and not interchangeable. HAZOP is cause driven and accepts a conclusion that a hazard cannot occur. HAZID is consequence driven and assumes that the hazard can occur.

HAZID studies are very broad in their scope, looking at all possible sources of hazard to a site examining a model at a time and postulate on mechanisms by which chosen hazardous events could occur.

HAZOP studies focus their attention primarily at the hardware of process and utility plant systems, examining a line at a time, and seek out possible specific deviations from the design intent by which a hazard could occur.

**8. HAZOP STUDIES IN OPERATION FACILITIES**

A HAZOP study of all or parts of an existing installation ideally should be carried out onsite and fully exploit operating experience of appropriate personnel. The team should have at least one senior operator who knows all the idiosyncrasies of how the process has to be operated. The benefit of a fresh view as seen by recent recruits can also be useful.
A possible drawback when carrying out studies on site is the risk that operations personnel may frequently be called away to deal with on-plant problems that arise. Proper delegation of responsibilities is needed to allow their attendance. A HAZOP study shall be carried out after a major or a significant number of process modifications and shall be included as a recommended study in the Management of Change procedure. A good industry practice recommends a HAZOP study for an operating facility to be performed every 3-5 years.

9. HAZOP STUDY ACTIVITY DIAGRAM

- Select a Node
- Explain the intention of the node
- Apply guideword
- Examine possible causes
- Examine consequences
- Record Control / Mitigation Measures
- Record Actions
- Repeat for all guidewords
- Mark off node as examined
- Repeat for all nodes
- Apply overview guideword
- Identify possible consequences
- Record Control / Mitigation Measures
- Record Actions
- Repeat for all overview guidewords
- Mark off overview as complete
10. GUIDEWORDS

For all sets, the selection of guidewords and how they are used is not fixed. The guidewords should be considered carefully as a guide word which is too specific may limit ideas and discussion and one which is too general may not focus the HAZOP study efficiently. Prior to commencing the study, the HAZOP facilitator must ensure that the guidewords to be used for a particular HAZOP session are appropriate for the system or sequence under review, the mode of operation i.e. batch or continuous and the objective of the HAZOP itself.

11. ACTIONS AND RECOMMENDATIONS

The basic purpose of a HAZOP study is to identify potentially hazardous scenarios from both a safety and an operational point of view. The results of a HAZOP study are often a list of hazardous incidents. Therefore, the team should not spend any significant time trying to engineer a solution if a problem is uncovered; the issue simply needs to be recorded and an appropriate action raised for investigation outside the HAZOP.

However, if a solution to a problem is obvious and cost effective, the team should document their recommended solution. If a solution is not obvious, then the team should recommend that someone follow-up and resolve the problem outside the HAZOP study.

In addition, if there is insufficient information available to decide if a potential problem exists, the team should note it as an "Action", assign someone in the HAZOP study team to carry out and arrange for additional information to be obtained and continue with the study. This person can then report back to the HAZOP team at a subsequent meeting. The team can then assess whether or not a potential hazard exists and whether a recommendation is needed.

If a problem is a lack of knowledge on the team's part, then other specialists may be called in.

12. HAZOP RECORDING

The HAZOP should be recorded using an appropriate, approved and robust software package. The ability to automatically process and produce HAZOP summary sheets and a HAZOP closeout database for the subsequent management and closeout of the HAZOP actions is highly desired. Using a recognized and approved software package will ensure a degree of consistency and familiarity with those involved. The HAZOP facilitator and scribe (if used) must be familiar with the package they are to use, and to ensure it meets project approval.

It is highly recommended that whatever package is used that a data projector is used during the workshop such that all participants can view the record, recommend modifications and agree the minutes and actions, thereby minimizing any revisions and modifications required later on.

Nodes should be sequentially numbered and recorded both within the HAZOP package and on the relevant design drawings, in addition the HAZOP package should clearly reference the study area e.g. P&ID numbers and their revision number.

There are three recognized methods of HAZOP recording – “By Exception”, “Intermediate” and “Full Record”. A “Full Record” means that the HAZOP should record all guidewords used, their cause, consequences and the safeguards, even if those existing safeguards are considered adequate and no action is required. For guidewords where there is no potential design deviation or hazard this too should be recorded, for example by "No hazards identified".
If multiple nodes of similar design / function are being examined, it is acceptable to record ‘by exception’. However, caution must be exercised when entering data into the software package – it is preferred to write ‘refer to Node #23’ than ‘refer to previous’.

13. HAZOP REPORT

Good communication of the results of the HAZOP is essential. This is not only to facilitate follow-up and closeout of the action items but to inform the concerned parties about the inherent hazards and operating problems of a particular plant, modification, procedure etc. and to highlight how these hazards and problems are to be addressed.

It should be noted that the HAZOP report is often the only record of the hazard / risk issues that is readily available to operations / maintenance groups after facility handover.

The HAZOP may generate a large number of worksheets, highlight a number of hazards and problems and generate a large number of action items and recommendations. An effective way to communicate the results of the HAZOP is to prepare a summary HAZOP report.

14. HAZOP ACTIONS CLOSEOUT

The Action Closeout is an important part of the HAZOP process. In principle, all actions raised in the HAZOP must be closed out; however, it can be difficult to manage if actions need to be deferred.

The method and responsibilities for HAZOP Action Closeout need to be determined with project manager, preferably at project commencement. As part of this, what ‘evidence’ is required for close-out needs to be agreed. For example, will the close-out sheet need a copy of the relevant (corrected) P&ID and/or procedure attached?

(Note Close-out of an action is slightly different to sign-off. With the sign-off process, the persons who sign are agreeing that the proposed solution will meet the intent of the HAZOP action, however it may not necessarily mean that the proposed action has actually been done.)

The best method of close out is to attach a copy of a marked-up design document, procedure or other evidence (such as e-mail from a third party) that the action has been addressed.

Where closeout of an action requires modifications to a key document (e.g. P&ID, equipment list etc.), the Key Document Change Notification process shall be followed and the approved Key Document Change Notification will be attached and form part of the closeout documentation.

Usually each HAZOP action has its own closeout sheet and once closed these should be printed out and signed off by the responsible parties and returned to the relevant members of the team for approval. The personnel required to sign off may vary between projects, but it is suggested that the following sign-off:

- The Actioner
- The Lead Discipline Engineer responsible for process scope of design (e.g. Process)
- The Project Manager or delegate

(Note that it is acceptable for the Actioner and Lead Discipline Engineer to be the same person).

15. DEVELOP YOUR OWN ORGANIZATION PROCEDURES

Although templates can give you a head start on procedures development, other factors must be considered as you write your own internal documents.

One factor is your organization’s culture. Organizational attitudes toward procedures determine the spectrum. On one end of the scale are companies that have a procedure for everything. At the other end of the spectrum are companies that only have only a few guidelines (only those required by the laws that
are relevant to that company). Most companies fall somewhere in between these two extremes. The manager writing any guideline needs to understand where on the spectrum the company it falls and how the policy can be made to fit the organization’s culture to enhance compliance.

Other two factors to be consider when developing guidelines and procedures are the fertilizer technology that company employs and local and international standards applicable to the industry. Internal standards and procedures must be developed in line with these factors, being applicable for your own plants and in line with regulatory requirements.

The last, but not least, factor when developing your own procedures is the best industry practice that you need to employ. Liaison with your fertilizer association, participation in industry meetings and conferences and using fertilizer industry consultants can bring a fresh eye, new ideas and enhance the quality of your own guidelines and procedures.

16. DEFINITIONS

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<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>HAZID</td>
<td>Hazard Identification Study</td>
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<tr>
<td>HAZOP</td>
<td>Hazard and Operability Study</td>
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<tr>
<td>HSEQ</td>
<td>Health Safety Environmental Quality</td>
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17. REFERENCES

4. AS/ IEC 6111: Functional Safety: Safety instrumented systems for the process industry sector

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