HAZOP Case Study – Blast Furnace

Project Number: 24-717.01.616-amns-st-hazop

HAZOP Study Serial Number: 616

1. Project Overview

A Hazard and Operability (HAZOP) Study was conducted for the Blast Furnace at ArcelorMittal and Nippon Steel India Private Limited, Hazira, Gujarat, in accordance with IEC 61882:2001. The objective was to systematically identify potential hazards and operability issues arising from deviations from design and operating intent.

The study involved critical project documents like Piping and Instrumentation diagrams (P&IDs), Standard Operating Procedures (SOPs), Cause and Effect (C&E) diagrams etc. A multidisciplinary team reviewed causes, consequences, safeguards, and risk levels, and gave recommendations to enhance process safety, reliability, and emergency preparedness.

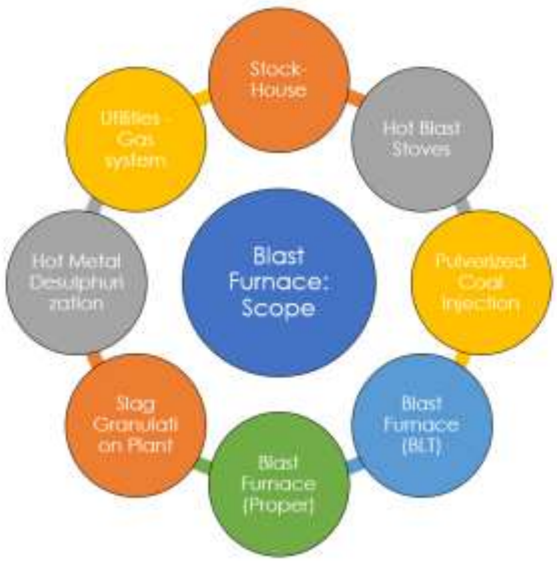
2. Objective

The objective of the HAZOP study was to systematically identify potential hazards and operability issues associated with the Blast Furnace and its associated systems, and to reduce the likelihood and consequences of incidents that could impact personnel safety, plant integrity, environmental performance, and operational reliability.

3. Methodology

HAZOP Preparation

Before arriving on-site, our team requested and analysed essential data, including Piping and Instrumentation diagrams (P&IDs) and Process Description. This allowed us to identify the Nodes and the nodes identified were discussed and finalised with AM/NS team before the start of the Study.



Opening Meeting

We initiated the on-site HAZOP process with an opening meeting to outline objectives, clarify roles, define the HAZOP methodology and procedure and gain commitment from the AM/NS Blast Furnace team.

HAZOP Brainstorming Session

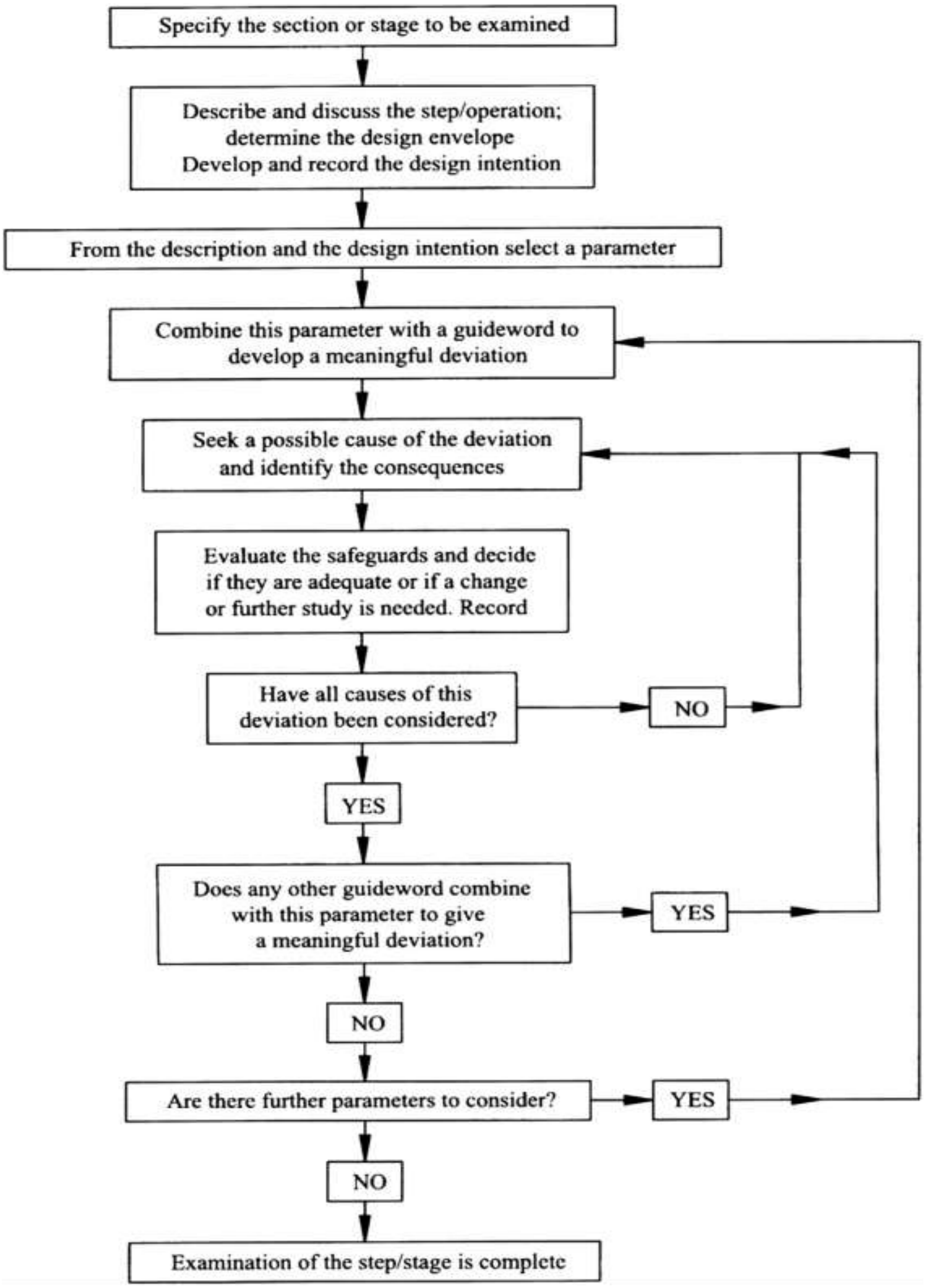
The HAZOP process was based on the principle that a team approach to hazard analysis will identify more problems than when individuals working separately combine results. The HAZOP team involved was combined of individuals with varying backgrounds and expertise. The expertise was brought together during HAZOP sessions and through a collective brainstorming effort that stimulates creativity and new ideas, and a thorough review of the process under consideration was made.

The HAZOP team focused on specific Nodes, which were identified before the start of the study. A process parameter was identified, say flow, and an intention is created for the node under consideration. Then a series of guidewords was combined with the parameter "flow" to create deviations. For example, the guideword "no" was combined with the parameter flow to give the deviation "no flow". The team then focused on listing all the credible causes of a "No flow" deviation beginning with the cause that can result in the worst possible consequence the team can think of. Once the causes are recorded the team listed the consequences, safeguards and any recommendations deemed appropriate. The process was repeated for the next deviation and so on until completion of the node and was repeated for all the Nodes under consideration.

Key distinctive characteristics of HAZOP:

- Risk Ranking was carried out in 3 stages which allowed us to evaluate the initial potential risk of consequence, mitigated risk after existing safeguards and residual risk after HAZOP recommendations if any.
- Various national and internationally accepted guidelines, standards and documents were used in the Study such as:
    - IEC 61882:2001
    - Centre for Chemical Process Safety
    - Gujarat Factory Rules
    - Relevant Material Safety Data Sheets (MSDS)
    - Indian Standards
    - ECHA for chemical information
- Rules followed for identifying safeguards:
    - **Rule 1:** Safeguards should act before the event happens
    - **Rule 2:** Approach for deciding type and number of Safeguards. For example: if 4 safeguards are required to meet the risk in ALARP (As Low as Reasonably Practicable) region, then minimum of 2 must be preventive, and 2 can be mitigative. Also, not more than 1 admin control should be there, SIS/SIFs and mechanical safeguards should also be there in adequate number.
    - **Rule 3**: Safeguards should be Measurable and Auditable (demonstrate the performance)
    - **Rule 4:** Safeguards should be independent.
    - **Rule 5:** Safeguards have the different **Probability of Failure on Demand (PFD)** and **Risk Reduction Factor (RRF).**
    - **Rule 6:** In HAZOP, consider failures of process control, not protection layers or safeguards.

- **Rule 7:** In Case of Redundancy of Safeguard, consider Single layer of Protection
- **Rule 8:** If Two Layer of Protection/Safeguards in Series, consider one. For example, RD and PSV in series are considered as one single safeguard.
- **Rule 9:** If Two Transmitters on same nozzle, consider Single protection layer



4. Key Outcomes

- Initial risk ranking without safeguards identified a significant number of High and Extreme risks. With the application of existing safeguards, many risks were reduced; however, some still required additional mitigation against which HAZOP team gave recommendations.

- Tolerable risks are largely well controlled by existing safeguards; HAZOP team gave recommendations in few actions for further improvement. Moderate risks were also well controlled by existing safeguards.

- All the cases of High and Extreme risks were mitigated by HAZOP recommendations with some cases recommended for further analysis/study.

5. Conclusion

The HAZOP study significantly reduced overall risk levels and highlighted scenarios requiring further evaluation. This case study demonstrates how a structured HAZOP approach effectively identifies hazards and operability issues in a complex iron-making Blast Furnace system. Overall, the case highlights the importance of systematic hazard identification, multidisciplinary participation, and implementation of recommendations in achieving safe and reliable blast furnace operations.