HAZOP (Hazard and Operability Study)

www.Instrunexus.com

Top 50 Interview Questions & Answers

Part 1: Fundamental Concepts

1. What is a HAZOP?

A **HAZOP** (**Hazard and Operability Study**) is a systematic and highly structured technique for identifying potential **hazards** and **operability problems** in a process plant. It uses a series of specific "guidewords" to examine the potential for deviations from the intended design.

2. What are the primary objectives of a HAZOP study?

The main objectives are to:

- Identify potential **hazards** that could lead to injury, environmental damage, or asset loss.
- Identify **operability problems** that could cause production loss, poor product quality, or equipment damage.
- Review the process design to ensure it is safe and can be operated as intended.
- Provide actionable **recommendations** to mitigate the identified risks.

3. What is the core principle of the HAZOP methodology?

The core principle is that hazards are created when a process deviates from its intended design conditions. The HAZOP team systematically brainstorms all credible ways a process can deviate by applying guidewords to process parameters.

HAZOP (Hazard and Operability Study)

www.Instrunexus.com

4. What is a "deviation" in HAZOP?

A deviation is a departure from the intended design or operating condition. It is created by combining a **guideword** with a **process parameter**.

- **Example:** Guideword = **NO**, Parameter = **FLOW**. The deviation is **NO FLOW**.

5. What is a "node"?

A **node** is a specific section of the process that is being studied, such as a single pipeline, a vessel, or a pump system. The HAZOP study is broken down into these manageable nodes, and the analysis is completed for one node before moving to the next.

6. What is the difference between a hazard and an operability problem?

- **Hazard:** A potential source of harm, typically related to safety and environmental consequences (e.g., a release of toxic gas, a fire, or an explosion). 💥
- **Operability Problem:** An issue that affects the plant's ability to run efficiently and produce quality products (e.g., a pump that cavitates, off-spec product, or a plugged line).

7. Is HAZOP a qualitative or quantitative risk assessment method?

HAZOP is a **qualitative** method. It identifies what *can* go wrong and the potential severity of the consequences, but it does not assign numerical probabilities or frequencies. It is a brainstorming and hazard identification tool.

8. What are the key elements of a HAZOP worksheet?

The worksheet is a table used to document the study. It typically includes columns for:

- **Deviation:** The guideword + parameter (e.g., HIGH PRESSURE).
- **Causes:** All credible reasons the deviation could occur.
- **Consequences:** The potential outcomes if the deviation occurs.

- **Safeguards:** Existing protection layers that prevent the cause or mitigate the consequence.
- **Recommendations:** Actions needed to reduce the risk to an acceptable level.

9. What is the "design intent"?

The design intent is a clear statement of how a piece of equipment or a process node is expected to work under normal conditions. This includes parameters like flow rate, temperature, pressure, and composition. The HAZOP study is a structured examination of what happens when the process deviates from this intent.

10. When in a project lifecycle should a HAZOP be conducted?

A HAZOP is most effective when conducted during the **detailed design phase** of a project. At this stage, the P&IDs (Piping and Instrumentation Diagrams) are finalized, but there is still an opportunity to make design changes before major construction and procurement costs are incurred.

Part 2: The HAZOP Team

11. Who are the essential members of a HAZOP team?

A typical HAZOP team is a multi-disciplinary group that includes:

- **HAZOP Leader/Facilitator:** An expert in the HAZOP methodology, responsible for guiding the team.
- **HAZOP Scribe/Secretary:** Responsible for accurately documenting the discussion on the worksheet.
- **Process Engineer:** The expert on the process design and chemistry.
- **Operations Representative:** Someone with practical experience running the plant.

- **Control/Instrument Engineer:** The expert on the control systems, alarms, and interlocks.

12. What other disciplines might be included in a HAZOP team?

Depending on the complexity of the node, other specialists may be included, such as:

- Mechanical Engineer
- Electrical Engineer
- Safety Specialist
- Project Manager
- Vendor Representative

13. What is the role of the HAZOP Leader?

The leader's role is critical. They must:

- Plan and prepare for the study.
- Lead the brainstorming sessions, ensuring the team stays focused and follows the methodology.
- Manage the team dynamics and ensure everyone contributes.
- Remain **neutral** and not influence the technical outcome.
- Ensure the results are clear, concise, and accurately recorded.

14. What is the role of the HAZOP Scribe?

The scribe works closely with the leader to:

- Accurately and efficiently document the team's discussion (causes, consequences, safeguards, recommendations) on the HAZOP worksheet using specialized software.
- Help the leader keep track of the study's progress.
- Read back the recorded information to the team to ensure it is correct.

15. Why is a multi-disciplinary team so important for a HAZOP?

A multi-disciplinary team is essential because no single person has all the required knowledge. The **synergy** of different perspectives (design, operations, control, maintenance) is what makes the HAZOP effective at identifying a wide range of potential problems.

Part 3: The HAZOP Process

16. What are the main steps in the HAZOP process?

The process can be broken down into four phases:

1. **Preparation:** Defining the scope, selecting the team, and gathering all necessary documents.
2. **Execution:** The brainstorming sessions where the team systematically works through each node.
3. **Documentation:** Finalizing the HAZOP report and worksheet.
4. **Follow-up:** Tracking the implementation and close-out of all recommendations.

17. What documents are required for a HAZOP study?

The most important documents are:

- **Piping and Instrumentation Diagrams (P&IDs):** The primary reference for the study.
- **Process Flow Diagrams (PFDs).**
- **Cause and Effect Charts.**
- **Control Narratives / Operating Procedures.**
- **Heat and Material Balances.**

18. How does the team analyze a node during the execution phase?

1. The leader presents the node and explains its design intent.
2. The leader selects a process parameter (e.g., FLOW).
3. A guideword is applied to create a deviation (e.g., MORE FLOW).
4. The team brainstorms all credible **causes** of this deviation.
5. For each cause, the team determines the potential **consequences**.
6. The team identifies existing **safeguards**.
7. The team decides if the safeguards are adequate. If not, a **recommendation** is made.
8. This process is repeated for all guidewords and parameters for that node.

19. What makes a good HAZOP recommendation?

A good recommendation should be **SMART**:

- **S**pecific: Clearly state what needs to be done.
- **M**easurable: Define what a successful outcome looks like.
- **A**ssignable: Assign the action to a specific person or department.
- **R**ealistic: Be achievable and practical.
- **T**ime-bound: Have a deadline for completion.
- **Bad Recommendation:** "Look into the pump."
- **Good Recommendation:** "Operations to verify if the PSV-101 sizing is adequate for the case of inadvertent opening of FV-101. Due by Oct 15."

20. What is a "parking lot" in a HAZOP meeting?

The "parking lot" is a list of important issues or questions that are raised during the meeting but are outside the immediate scope of the HAZOP. These are documented to ensure they are addressed later, preventing the team from getting sidetracked.

HAZOP (Hazard and Operability Study)

www.Instrunexus.com

Part 4: Guidewords & Deviations

21. What are HAZOP guidewords?

Guidewords are short, simple words used to prompt the team to think about how a process might deviate from its design intent.

22. What are the most common HAZOP guidewords and their meanings?

- **NO / NOT:** Complete negation of the design intent (e.g., NO FLOW).
- **MORE / HIGH:** A quantitative increase (e.g., HIGH PRESSURE, MORE FLOW).
- **LESS / LOW:** A quantitative decrease (e.g., LOW TEMPERATURE, LESS FLOW).
- **AS WELL AS:** An additional activity occurs (e.g., an impurity is present AS WELL AS the main component).
- **PART OF:** Only some of the design intent is achieved (e.g., only one component of a mixture is added).
- **REVERSE:** The logical opposite of the intent occurs (e.g., REVERSE FLOW).
- **OTHER THAN:** A completely different activity occurs (e.g., a different material is transferred OTHER THAN the correct one).

23. What are the common process parameters the guidewords are applied to?

- **Physical Parameters:** FLOW, PRESSURE, TEMPERATURE, LEVEL.
- **Process Variables:** COMPOSITION, VISCOSITY, pH.
- **Operational Parameters:** MIXING, REACTION, START-UP, SHUTDOWN.

24. Give an example of creating and analyzing a deviation.

- **Node:** Cooling water supply to a reactor.
- **Parameter:** FLOW.
- **Guideword:** NO.

- **Deviation: NO FLOW** of cooling water.
- **Causes:** Pump failure; closed valve; plugged line; loss of power.
- **Consequences:** Reactor overheats; runaway reaction; high pressure; potential vessel rupture.
- **Safeguards:** Low flow alarm (FA-101); high temperature alarm (TA-102); high pressure interlock (PSH-103) that shuts down the feed.
- **Recommendation:** (If safeguards are inadequate) "Consider adding an independent high-high temperature trip to provide an additional layer of protection."

25. What is the difference between MORE and AS WELL AS?

- **MORE** refers to a quantitative increase in something that is *supposed* to be there (e.g., MORE FLOW of reactants).
- **AS WELL AS** refers to the presence of an *additional*, unwanted component (e.g., water is present AS WELL AS the intended solvent).

26. How is the guideword "REVERSE" used?

It is used to analyze the possibility of the process moving in the wrong direction. A classic example is **REVERSE FLOW** through a check valve, which could lead to contamination of an upstream system.

27. When would you use the guideword "OTHER THAN"?

This is used for scenarios involving incorrect materials or operations. Examples include:

- Connecting the wrong chemical tote to a pump (**OTHER THAN** correct material).
- Starting a batch sequence at the wrong time (**OTHER THAN** correct timing).

28. What are "safeguards"?

Safeguards are any existing engineered systems, procedures, or design features that are in place to prevent the cause of a deviation or mitigate its consequences.

29. What are some examples of typical safeguards?

- **Engineered Controls:** Alarms, interlocks, pressure relief valves (PRVs), emergency shutdown systems (ESD).
- **Design Features:** Check valves, correctly sized equipment, dikes and bunds.
- **Procedures:** Standard Operating Procedures (SOPs), operator training, routine inspections.

30. How do you decide if the existing safeguards are adequate?

The team uses its collective experience and, often, a company's **risk matrix** to make a judgment call. If a scenario has a high potential severity and the existing safeguards are weak or not independent, they are likely inadequate. This is a qualitative judgment.

Part 5: Practical Application & Scenarios

31. Why is human error considered a cause in a HAZOP?

Human error is a significant contributor to industrial accidents. A HAZOP must consider credible mistakes that an operator could make, such as:

- Opening the wrong valve.
- Setting an incorrect controller setpoint.
- Forgetting a step in a procedure.

32. How do you HAZOP a batch process differently from a continuous process?

For a **batch process**, you must also use guidewords related to **time and sequence**, such as:

- **EARLY / LATE:** An action is performed at the wrong time.
- **BEFORE / AFTER:** Steps are performed in the wrong order. This is because the timing and sequence of additions and operations are critical in a batch process.

33. What is a "double jeopardy" scenario, and how is it handled?

Double jeopardy refers to a scenario that requires two independent, simultaneous failures to occur. For example, a control valve failing open *and* its associated relief valve failing to open. Generally, these scenarios are considered non-credible and are not analyzed in a HAZOP unless the failures have a common cause or one is a hidden failure.

34. What is a "hidden failure"?

A hidden (or dormant) failure is a fault in a protective device that is not revealed until the device is called upon to act. For example, a relief valve that is corroded shut is a hidden failure. This is why regular proof testing of safety devices is critical.

35. How do you handle a scenario with very severe consequences?

If a scenario has a potentially catastrophic consequence (e.g., fatality, major explosion), the team will scrutinize the safeguards very carefully. Even if the cause seems unlikely, the severity of the outcome often warrants a recommendation for a robust, high-integrity protection layer, like a safety interlock.

36. Is "operator training" a strong safeguard?

While essential, operator training is generally considered a **weaker** or "soft" safeguard compared to an engineered control like an interlock. It is susceptible to human factors. It can be listed as a valid safeguard, but a HAZOP team will rarely rely on training alone to protect against a high-risk scenario.

37. What is an alarm, and can it be a primary safeguard?

An alarm is a device that alerts an operator to an abnormal condition. An alarm *coupled with an effective operator response* can be a valid safeguard. However, the team must consider if the operator has enough time to act, if the action is clear, and if there are too many other alarms ("alarm flooding").

38. What is an interlock?

An interlock, or trip, is an automated safety function that takes action without human intervention. For example, a high-level switch in a tank that automatically closes the inlet valve. Interlocks are considered very strong safeguards.

39. How do you close out a HAZOP recommendation?

The assigned person or department must complete the recommended action. They then need to provide documentation (e.g., an updated P&ID, a new procedure, a calculation sheet) as evidence that the action has been completed. This evidence is reviewed, and the recommendation is formally "closed out."

40. What is a "bow-tie" diagram?

A bow-tie diagram is a visual way to represent a hazardous scenario.

- The **left side** of the bow tie shows the **causes** (threats) leading to the central event (the knot). The safeguards that prevent the event are shown as barriers on these paths.
- The **right side** shows the potential **consequences** branching out from the event. The safeguards that mitigate the consequences are shown as barriers on these paths. It's a useful tool for communicating the results of a HAZOP.

HAZOP (Hazard and Operability Study)

www.Instrunexus.com

Part 6: Context, Comparison & Limitations

41. How does HAZOP relate to LOPA?

HAZOP identifies the hazards, and **LOPA (Layer of Protection Analysis)** analyzes them. The high-risk scenarios identified in a HAZOP are often the direct input for a LOPA. LOPA is a semi-quantitative method used to determine if the safeguards identified in the HAZOP are sufficient to meet a company's risk tolerance criteria.

42. What are some alternatives to HAZOP?

- **What-If Analysis:** A less structured brainstorming method where the team asks "What if…?" questions (e.g., "What if the pump stops?").
- **Checklist Analysis:** Uses a pre-defined list of known hazards and questions. Good for standard equipment but may miss unique process hazards.
- **Failure Modes and Effects Analysis (FMEA):** A bottom-up method that looks at the failure modes of individual components and their effect on the system.

43. What are the main limitations of a HAZOP?

- It is only as good as the information provided (e.g., accurate P&IDs) and the experience of the team.
- It is a very time-consuming and therefore expensive process.
- It focuses on single-cause, single-consequence events and is not well-suited for analyzing complex, multi-cause scenarios.
- The quality of the outcome is highly dependent on the skill of the HAZOP leader.

44. How often should a HAZOP be revalidated?

For processes covered by regulations like OSHA's Process Safety Management (PSM) in the US, the PHA (which is often a HAZOP) must be revalidated at least **every five years**. A HAZOP should also be updated whenever there is a significant change to the process.

45. Can you do a HAZOP on a procedure?

Yes. This is called a **Procedural HAZOP**. The team breaks down the procedure into steps and applies guidewords like **EARLY, LATE, SKIPPED, or WRONG ORDER** to identify potential human errors and their consequences.

46. What is the difference between a project HAZOP and a revalidation HAZOP?

- **Project HAZOP:** Performed on a new design. The focus is on identifying design flaws and ensuring the plant will be safe to build and operate.
- **Revalidation HAZOP:** Performed on an existing, operating plant. It reviews the original HAZOP but also incorporates operating experience, incident history, and any changes made over the last several years.

47. How do you prepare to be an effective participant in a HAZOP?

Before the meeting, you should thoroughly review the P&IDs and any other process documents for the nodes being studied. Come prepared to actively participate, share your specific expertise, and ask questions.

48. What is a "SIL Assessment"?

A SIL (Safety Integrity Level) Assessment is a process to determine the required reliability for a safety interlock. LOPA is the most common method used to perform a SIL Assessment. The HAZOP identifies the need for the interlock, and the LOPA determines how reliable it needs to be (its SIL rating).

49. Why is "scope definition" so important in the preparation phase?

Clearly defining the scope (the boundaries of what will and will not be studied) is critical to keep the HAZOP focused and on schedule. Without a clear scope, the team can easily get sidetracked into discussing problems that are irrelevant to the process being studied, wasting valuable time.

50. What do you believe is the single most important factor for a successful HAZOP?

The single most important factor is the **quality and engagement of the team**. A well-prepared, multi-disciplinary team with an experienced leader, working collaboratively in an open environment, will always produce a more thorough and effective study than a team that is disengaged or lacks the right expertise. The methodology is a tool; the people using it are what make it successful. 🤝