Department of **Energy, Mines, Industry Regulation and Safety**

GOVERNMENT OF WESTERN AUSTRALIA

WorkSafe Western Australia Petroleum Safety

INFORMATION SHEET

Human factors in the HAZOP process

Introduction

The hazard and operability analysis (HAZOP) is a widely used and comprehensive method for process safety in major hazard facilities and petroleum and geothermal energy operations. The result of a HAZOP is a set of identified process hazards and list of actions to mitigate these. These results are also used to inform later stages in the project such as the construction and operation of systems. An inadequate HAZOP can lead to incidents with serious consequences; therefore, it is critical that the quality of the HAZOP is as high as possible. One way to improve the quality is by ensuring that there is consideration of the human factors that impact the HAZOP process.

Scope and objectives

This document provides information on human factors for operators to consider in their HAZOP processes. It covers human factors within the system: the individual, the job and the organisation. It should be noted that factors across these three main areas will often overlap because of how interrelated a system is, but they can be broadly categorised into one of the three. This document provides information on how those factors influence a HAZOP and advice on how to mitigate these influences.

Definitions and abbreviations

HAZOP – the hazard and operability analysis is a well-known process hazard analysis technique that involves identifying potential hazards and risks or deviations from intended work.

Why it is important to consider human factors in HAZOPs

The HAZOP process can be complex and time-consuming, with some HAZOP meetings stretching over days. The nature of a HAZOP means that a lot of cognitive demand is placed on the team, and this can increase the chance of errors or information being missed. One of the core human factors principles is that variations and mistakes in human performance are normal; therefore, the mitigation of influencing factors to reduce the possibility of mistakes is vital. When there is a lack of quality in a HAZOP, this may lead to the occurrence of incidents and losses. To improve the quality and conduct adequate HAZOPs, a focus on human factors during the process is necessary, as this can influence the performance of the team in carrying out the HAZOP.

Individual factors

The following section identifies the individual factors that may influence a person's performance during a HAZOP.

Heuristics and biases

Heuristics are mental shortcuts that help people make decisions quickly. Heuristics are efficient and useful, but can lead to incorrect judgements and assumptions. Cognitive biases are often subconscious and may influence judgements and decisions. Both impact a HAZOP because they can lead to inaccurate risk perceptions, inaccurate estimations of event probabilities, or flawed decisions being made.

Reducing the influence of heuristics and biases starts by being aware of these subjective influences. There are strategies that can be implemented to aid decisions in the HAZOP, such as:

- Challenging decisions by building in questions for the team so that they can check in on their decision making. For example, questions like "have all possibilities been objectively considered?" or "what evidence are we using to make this prediction?"
- Seeking dissenting views by welcoming people to share differing thoughts or help the team reconsider decisions.

Some common heuristics and biases are listed below.

Availability bias

The availability bias is when people think of events as more frequent or likely because they come to mind quickly or vividly. An example is that major events such as shark attacks come to mind more easily because of how intense and frightening the prospect of an attack is. This leads to people often overestimating the chances of bad events happening to them and can alter the perception of how likely an event might happen.

Optimism bias

Optimism bias is about being over-optimistic and underestimating the likelihood of negative outcomes, choosing to believe that outcomes will mainly be positive.

Normality bias

The normality bias is the tendency to underestimate the likelihood or the impact of a hazard because of the belief that things will be 'normal' and continue to be normal. For example, people sometimes fail to prepare adequately for natural disasters due to this bias because they underestimate the chance of it happening and impacting their normal lives.

Authority bias

Authority bias is the tendency to trust the opinion of an authority or expert figure regardless of the actual content they are providing.

Groupthink

Groupthink is where a group of people tend to think alike and agree on decisions as a group even if individuals in the group might not agree with the decision. This tendency comes from the desire to maintain harmony and conformity in the group, but it may lead to poor quality decision making.

Creativity

Creativity is needed in HAZOPs to think of novel hazardous scenarios or possible deviations from intended work. Creativity is not something that comes to everyone easily and some people think creatively when given time for contemplation and time to process information. It can be hard to think of new scenarios outside of what has been experienced, especially if there is not much time given.

Other factors such as how tired someone is, or if someone is stressed about other tasks, would hinder a person's ability to be creative as well.

A way to facilitate creativity is by having follow up sessions or a time at the start of the next HAZOP session to provide an opportunity for people to share additional ideas. This acknowledges that brainstorming and additional ideas can occur outside of the HAZOP sessions.

Considering how to mitigate other factors that might affect creativity such as fatigue and time pressure will also foster better creativity. These factors are discussed later in this document.

Memory

Memory is depended on during HAZOPs because the team needs to recall information about past safety incidents and past discussions. If the memory of past events is not accurate, there could be misinformation that leads to inaccurate outcomes. Memories are prone to error and biases that impact how we recall information.

To reduce the reliance on people's memories, it is recommended to take and use detailed written records during the HAZOP sessions. This includes bringing written records of past incidents and events to refer to during the HAZOP sessions.

Documenting and recording discussions and decisions during HAZOP sessions may also be helpful for memory consolidation. Summaries can be sent out to team members after sessions so they have a record of what was discussed. This is usually done by an assigned scribe who can take notes about the decisions or scenarios.

Job factors

The following section identifies the job factors that may influence a person's performance during a HAZOP.

Cognitive load

HAZOP meetings can be cognitively demanding and mentally exhausting because of the amount of technical information and type and intensity of mental processed required. High cognitive load for an extended time can be tiring and lead to fatigue, which is not beneficial for any type of work.

To mitigate a high cognitive load, the following strategies might be helpful:

- having frequent breaks throughout the session to give the team a time to refresh and rest
- spreading out the meetings over days rather than having long meetings that stretch beyond normal work hours
- sending out information about the HAZOP session in advance so that team members have time to acquaint themselves with the information. This will reduce the amount of new information they have to process during the HAZOP session.

Time pressure

Time pressure can interfere with someone's decision making, creativity, motivation, as well as mood. This pressure might come from having a limited time to complete the HAZOP session, or it might be from team members having other work tasks on their mind that they need to get done.

To reduce this time pressure, there should be reasonable and sufficient time allocated for the HAZOP so that the team won't feel the need to rush and finish the session in a certain time. For this to be possible, management must be aware of the importance of the HAZOP and be on board with allowing more time and resources for it.

Work environment

Work environment is the conditions of the place where people are working. Uncomfortable or distracting work environments won't be beneficial for the team who are trying to conduct the HAZOP. Optimal conditions for working environments to facilitate productivity include:

- adequate lighting
- no noise disturbances or interruptions during the meeting
- sufficient ventilation and good air quality
- enough space in the room to seat everyone without crowding
- comfortable temperature (not too cold or too hot).

Organisation factors

The following section identifies the organisation factors that may influence a person's performance during a HAZOP.

Resources

Resources for the HAZOP are an important factor because appropriate and sufficient resources can affect the quality of the HAZOP. This includes having qualified team members such as technical specialists who have competency and experience in various relevant disciplines (i.e. process designers, engineers, operations personnel, safety professionals and more). The availability of these team members is something the organisation needs to support and provide, so that the full range of necessary skills and knowledge can be present at the HAZOP.

Aside from technical specialists, having appropriate personnel who have HAZOP management experience is also important, and this includes having an experienced facilitator and a scribe who can effectively document the HAZOP.

Lastly, the provision of a suitable location to meet is needed and sufficient time provided for the HAZOP to be carried out effectively.

Facilitator

The facilitator of the HAZOP plays a very important role in guiding the process. The facilitator needs to have good technical skills about the HAZOP process and systems, as well as interpersonal and facilitation skills so that they can guide the team to work effectively. They must be able to understand group dynamics and adapt to the needs of the group, such as by monitoring when a break is needed, and helping create a safe environment for the team members to share their thoughts freely. They also need experience and skills in managing HAZOPs, such as recognising when to spend more time on a problem or when to progress instead of staying on one idea for too long.

Another important consideration is the position of the facilitator as this can influence team members willingness to speak up. It is best for the facilitator to be as impartial as is reasonably possible within the system and to be someone that team members feel comfortable speaking up in front of.

Additional information and resources

P. Aspinall (2006), HAZOPS and human factors, IChemE Symposium Series No. 151.

Graeme R. Ellis and Andrew Holt (2009), A practical application of 'human-HAZOP' for critical procedures, IChemE Symposium Series No. 151.

Silje Arendt Olsen, et al. (2020), Impact of human and organizational factors applying HAZOP: Results from a systematic literature review and interviews, *Proceedings of the 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assessment and Management Conference*. Piero Baraldi, Francesco Di Maio and Enrico Zio (eds), Research Publishing, Singapore.

WorkSafe WA (2023), HAZOP considerations: Putting people first, Technical session presentation, Petroleum Safety and Dangerous Goods Human Factors Industry Forum 2023.

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