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Chemical engineering

Question 1

A hazard and operability study (HAZOP) is a structured and systematic examination of a complex planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment. The intention of performing a HAZOP is to review the design to pick up design and engineering issues that may otherwise not have been found. The technique is based on breaking the overall complex design of the process into a number of simpler sections called 'nodes' which are then individually reviewed. It is carried out by a suitably experienced multi-disciplinary team (HAZOP) during a series of meetings. The HAZOP technique is qualitative, and aims to stimulate the imagination of participants to identify potential hazards and operability problems. Structure and direction are given to the review process by applying standardised guide-word prompts to the review of each node. The relevant international standar] calls for team members to display 'intuition and good judgement' and for the meetings to be held in 'a climate of positive thinking and frank discussion'.

The HAZOP technique was initially developed in the 1960s to analyze major chemical process systems but has since been extended to other areas, including mining operations and other types of process systems and other complex systems such as nuclear power plant operation and software development. It is also used as the basis for reviewing Batch processes and operating procedures.

The method is applied to complex 'processes' for which sufficient design information is available, and not likely to change significantly. This range of data should be explicitly identified and taken as the ‘design intent’ basis for the HAZOP study. For example, a prudent designer will have allowed for foreseeable variations within the process creating a larger design envelope than just the basic requirements and the HAZOP will be looking at ways in which this might not be sufficient.

For processes plant, the nodes are chosen so that for each a meaningful design intent can be specified and they are commonly indicated on piping and instrumentation diagram (P&IDs) and process flow diagram (PFD). The extent of each node should be appropriate to the complexity of the system and the magnitude of the hazards it might pose. However, it will also need to balance between "too large and complex" (fewer nodes, but the team members may not be able to consider issues within the whole node at once) and "too small and simple" (many trivial and repetitive nodes, each of which has to be reviewed independently and documented).

For each node in turn the HAZOP team uses a list of standardised guide-words and process parameters to identify potential Deviations from the design intent. For each deviation, the team identifies feasible Causes and likely Consequences then decides (with confirmation by subsequent risk analysis where necessary) whether the existing safeguards are sufficient, or whether an Action to install an additional safeguard is necessary to reduce the risks to an acceptable level.

The degree of preparation for the HAZOP is critical to the overall success of the review - 'frozen' design information provided to the team members with time for them to familiarise themselves with the process, an adequate schedule allowed for the performance of the HAZOP, provision of the best team members for their role. Those scheduling a HAZOP should take into account the review scope, the number of nodes to be reviewed, the provision of completed design drawings and documentation and the need to maintain team performance over an extended time-frame. The team members may also need to perform some of their normal tasks during this period and the HAZOP team members can tend to lose focus unless adequate time is allowed for them to refresh their mental capabilities.

The team meetings should be managed by an independent, trained HAZOP Facilitator who is responsible for the overall quality of the review, partnered with a dedicated Scribe to minute the meetings. "The success of the HAZOP study strongly depends on the alertness and concentration of the team members and it is therefore important that the sessions are of limited duration and that there are appropriate intervals between sessions. How these requirements are achieved is ultimately the responsibility of the study leader."

For a medium-sized chemical plant where the total number of items to be considered is 1200 (items of equipment and pipes or other transfers between them) about 40 such meetings would be needed.Various software programs are now available to assist in meetings.

QUESTION 2

The purpose of the HAZOP is to investigate how the system or plant deviate from the design intent and create risk for personnel and equipment and operability problems. HAZOP studies have been used with great success within chemical and the petroleum industry to obtain safer, more efficient and more reliable plants.

(1) The HAZOP process is a systematic examination.

(2)The team approach to a HAZOP makes it a multidisciplinary study.

(3) The HAZOP team utilizes operational experience.

(4) The process covers safety as well as operational aspects.

(5) Solutions to the problems identified may be indicated.

(6) HAZOPs consider operational procedures.

(7) HAZOPs cover human errors.

(8) The HAZOP study led by independent person.

(9) HAZOP study results are recorded.

(10) For team members the process is easily learned and performed.

(11) A HAZOP does not require considerable technical expertise for technique formulation.

(12) As a systematic process it provides rigor for focusing on system elements and hazards.

(13) The HAZOP process is a team effort with many viewpoints.

(14) Commercial software is available to assist in HAZOP analysis.

Question 3

