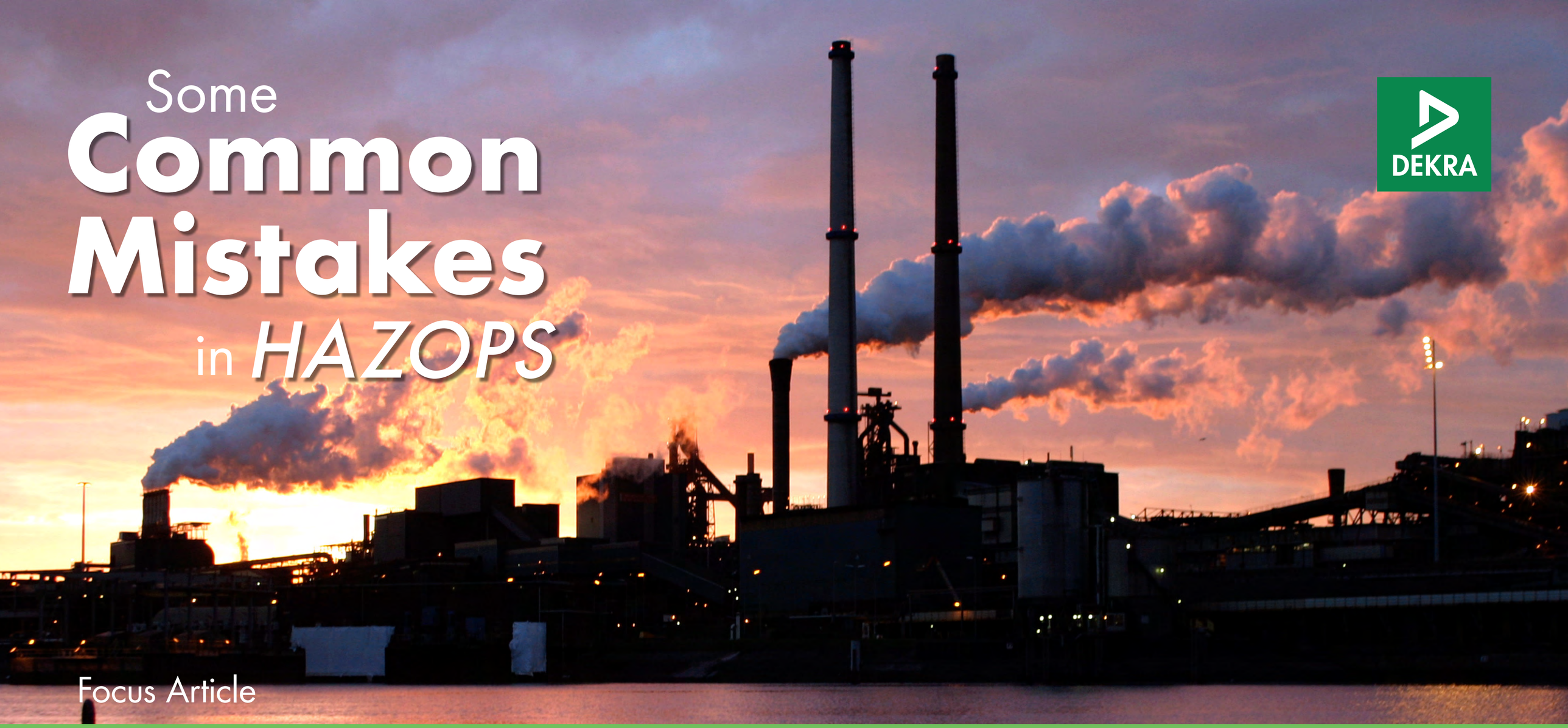

Some Common Mistakes in *HAZOPS*

Focus Article

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Over the past few decades, a Hazard and Operability Study (HAZOP) has been one of the most powerful tools for identifying process hazards. In addition, with the use of tools such as Layer of Protection Analysis, HAZOP is increasingly used for risk assessment and prioritizing risk-mitigation actions. Because conducting a HAZOP is time-consuming, ensure that the results justify the effort. In this paper, we point out some of the most common pitfalls, which can result in inefficiency and how to avoid them.

Hazard and Operability Study (HAZOP)

Here are some of the advantages of conducting a HAZOP:
- A rigorous character: structured, systematic, and comprehensive
- Easy to learn and apply
- Adaptable to the majority of process-industry operations
- The exchange of the knowledge and experience of the participant.
- Helps anticipate potential accidents

It teaches participating personnel to look at the process from another perspective, not at how it should run but how it can fail to run correctly. Nevertheless, it should be kept in mind that a HAZOP is an expensive tool since it requires the dedication of a multi-disciplinary team over sometimes extended time frames. Such a team is made up of people with important responsibilities (engineering, maintenance, operations, etc.) who need to juggle these responsibilities while the HAZOP is being carried out. This significant cost means that the performance of the HAZOP needs to be optimized in order to maximize its possibilities and amortize the investment of time and effort.

The Gaseous HAZOP

One of the most frequent mistakes is seen in planning. The mistake involves the establishment at the outset, often by neither the HAZOP coordinator nor the team, of a fixed duration of the HAZOP. The expectation is to meet this goal, even if this means contracting the HAZOP to fit in the time available for its completion, like a compressed gas. This mistake must be avoided at all costs because it is also potentially one of the most damaging, being the source of others, which will be listed below.

Obviously, a HAZOP cannot be undertaken as an exercise with an indeterminate duration. This is especially true when it is part of a project schedule, with milestones to be achieved. In any event, the participation of the managers and employees must be optimized. Nevertheless, we have, on occasion, attended HAZOPs whose duration, fixed in advance by people outside the group, made it necessary to limit possible discussion. This restricts crucial brainstorming and reduces the quality of the analysis.

Estimating the duration of a HAZOP is not, of course, an exact science. It requires a good knowledge of the methodology, the complexity of the process, the nature of the risks that can be identified upfront and, of course, the idiosyncrasies of the group. In no case should a HAZOP be carried out without an estimated agenda, but it is not acceptable for the estimation to be rigid and not subject to modification (up or down), as necessary. *The HAZOP should take as long as is required to do a thorough job but not a minute longer.*

The Poorly Prepared HAZOP

Another common mistake is not to have the information required for a HAZOP readily available. Even worse, to have outdated or incomplete information. This is especially critical regarding process and instrument diagrams (P&IDs). Experience shows that trying to facilitate a HAZOP with obsolete P&IDs becomes a game of finding the errors instead of the brainstorming focused on the process exercise it ought to be. Again, a waste of valuable team's time that could be avoided if the facilitator had checked beforehand that the information available was complete and adequate.

Of course, an external facilitator will hardly know if the information is updated. But at least, its completeness should be checked, and a feeling for its accuracy should be obtained from the client. Certainly, to postpone a HAZOP until proper information can be gathered is a wiser counsel than wasting time and effort in a rush HAZOP.

The Revolving-Door HAZOP

Under this heading, we refer, obviously, to the countless HAZOPs that have members of the group continually getting in and out of the meeting room or taking calls.

Although some people might have other opinions, a HAZOP is a complex exercise that requires the concentrated and coordinated contribution of all the members of the team. Any distraction can mean a worthwhile idea being lost, especially when the safety of the people who work there is at stake. Therefore, it is vital for the HAZOP group to be limited in size (ideally, up to six people, excluding the HAZOP facilitator and, if there is one, the HAZOP scribe). In addition, the group must remain focused, applying, at all

times, the adage that in a HAZOP, there are no assistants, only participants. Logically, it will be up to the HAZOP facilitator to schedule the necessary breaks to guarantee the team's concentration. We recommend at least one pause every two hours.

It is not acceptable to attend a HAZOP to obtain information on a plant or project. HAZOP participants should, on the contrary, be well prepared in order to contribute to the discussion, using their knowledge and experience.

At worst, if a large number of HAZOP participants are not sufficiently familiar with the plant or process, the meeting can turn into a review of P&IDs and value engineering. Obviously, this is one of the best ways of wasting the HAZOP participants' time and of arriving at a poor-quality result.

At the other extreme is the HAZOP without the minimum essential personnel. A HAZOP is a brainstorming exercise requiring the contribution of ideas by people who see the plant or process being studied from different points of view. It is complicated to establish the maximum and minimum number of participants in a HAZOP, since the various functions necessary may be assumed in different ways in different organizations. Nevertheless, it is safe to say that a HAZOP with fewer than three participants (excluding the HAZOP director and secretary) cannot generate sufficient discussion. Another point is the need for specific areas of expertise. For example, the team will never identify the potential for a dust explosion or a runaway reaction, if nobody on the team has any knowledge of these phenomena. If team members do not have this expertise, external specialists can be used.

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The Minimalist HAZOP

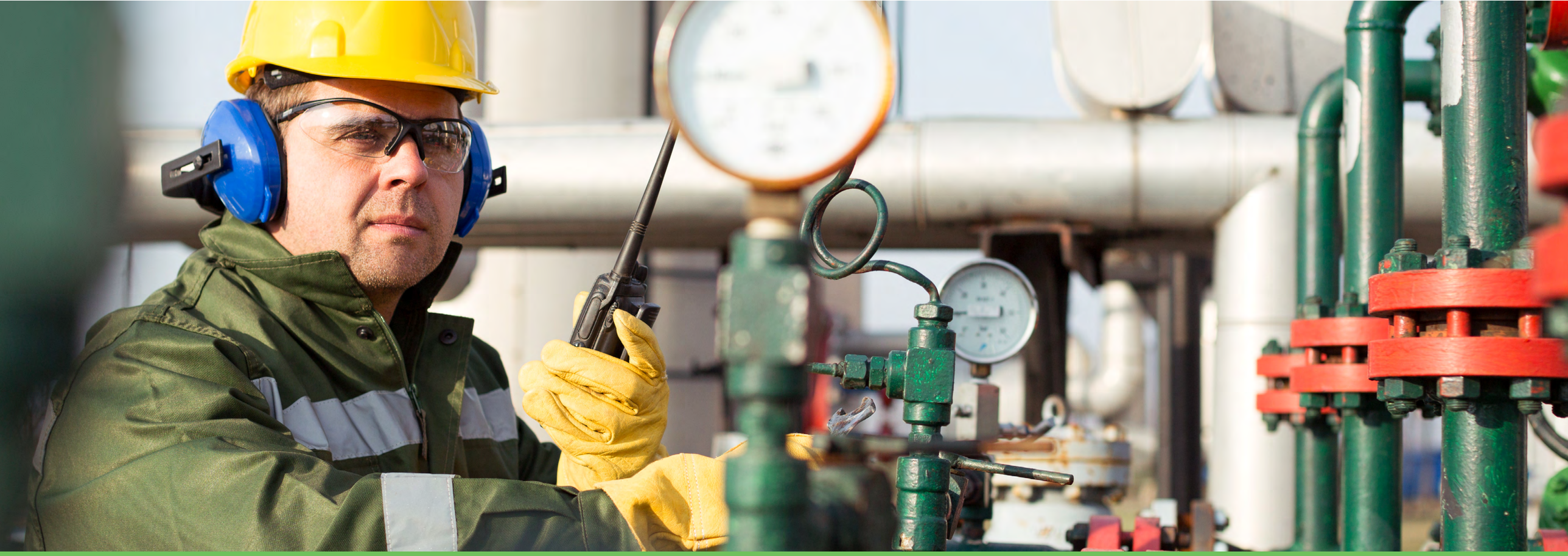
Another frequent mistake when conducting HAZOPs is to restrict the brainstorming exercise that constitutes the basis (and the power) of the method. Of course, various approaches or deviations from the method have been developed, which can be grouped under this heading. The most common are the following:

- Omitting key words, parameters or even nodes, with the argument that the worst-case consequences in this node can be easily identified and are protected by safeguards. It is indisputable that, on many occasions, strict application of the methodology will not identify any scenarios other than the obvious ones, which had already been listed upfront as an argument for omitting any further analysis. Nevertheless, sometimes a non-obvious scenario will be identified, which constitutes the purpose of the HAZOP. This is where it demonstrates its power.

- Carrying out a superficial review of the combinations of key words and parameters, listing the most obvious (and often repetitive) causes of deviation without going into detail. Obviously, it is more comfortable for the group to simply repeat the same causes, parameter after parameter and node after node, than to carry out a more in-depth analysis. As is logical, the quality of the HAZOP is also, thereby, compromised, and the possibility of avoiding some nontrivial risk scenario is palpable.

- Carrying out HAZOPs using some form of prior information: templates, the HAZOP from a similar project, etc. Again, what the HAZOP is meant to do is analyze the possible specific risk scenarios (especially the non-obvious ones) of the plant or project being studied. It will be much more comfortable for the group to base itself on past information. But the obvious risk is to carry out a read-through exercise, totally alien to the spirit of a HAZOP carried out correctly. Good results have been obtained by utilizing past information to ensure that scenarios have not been overlooked.

In the final analysis, it is the responsibility of the HAZOP facilitator to make sure that the group does not commit any of these perversions of the method.



The Bureaucratic HAZOP

An alternative form of the aforementioned mistake is to interpret the HAZOP spreadsheet as a questionnaire whose boxes all have to be filled in, even with numerous repetitions of scenarios. Nothing could be further from the purpose of the HAZOP. The combinations of key words and parameters are not intended to be an end in themselves but to encourage discussion. The same deviation, generally, causes the alteration of more than one process parameter and, therefore, could be entered in more than one place on the spreadsheet. An obvious example is a distillation column, in which pressure, temperature, composition, and flow rate (of reflux, for example) are clearly interrelated. Therefore, any deviation of one of the parameters automatically causes that of the others.

It is not as important for all the spreadsheet boxes to be filled in, as it is for the HAZOP group to work effectively in identifying all the possible deviations. It is up to the HAZOP facilitator to ensure that the group remains focused on brainstorming and not limit itself to regarding the HAZOP table as simply a form-filling exercise.

Safeguards and Recommendations

Safeguards

A large number of problems affect safeguards. The most blatant case is to list safeguards that, in reality, are nothing of the sort. The following are some examples:

- Local instruments that are never checked by field operators and, therefore, could in no way be considered safeguards.

- Alarms that give the operator insufficient time to effectively halt the deviation, because the rate of upset is too fast. Examples:
  - Very generic alarms, which are activated in numerous different situations. In this case, the operator must diagnose which of the multiple options he/she is faced with, thereby losing valuable time for action.
  - Alarms that are activated frequently, often for trivial reasons, and tend to be ignored by the operators.
  - Cascades of alarms.

- Pressure-relief systems (safety valves, rupture discs) for which there is no guarantee that they were designed for the case being studied. For example, in the accident that occurred on December 19, 2007, in T2 Laboratories, the rupture disc opened, but despite this, the reactor exploded, causing the death of four people, injuring 13, and causing extensive material damage. Obviously, the purpose of a HAZOP is not to verify the correct design of pressure-relief systems. Nevertheless, if there is reasonable doubt, a recommendation should be issued to check that the scenario for which it was listed as a safeguard was one of the cases of design.

- Operating procedures as a safeguard, when the cause giving rise to the scenario is human error (which presupposes that the procedure was not followed properly).

Recommendations

One of the end products obtained from a HAZOP is a report, including recommendations to improve the safety of the plant or process. Mistakes can also be produced at the time of writing up the conclusions. The most common ones are:

- Some HAZOP groups consider that they have to issue a recommendation for any scenario that has safety or environmental consequences. Obviously, this is not in the spirit of the method. What a HAZOP aims to do is to identify all the risk scenarios, check whether they have been sufficiently protected by the safeguards and propose recommendations. This way of proceeding results in very long recommendation reports, not all necessarily useful; and what is worse, this background noise masks the recommendations that are really important. The use of some system for quantifying risk and categorizing acceptable and unacceptable risks helps avoid such situations.

- Taking advantage of the HAZOP to write a Christmas list. Incredible as it may sound, this is a situation that arises quite frequently. Sometimes, people will try to use a safety-oriented HAZOP to resolve an issue unrelated to safety, which can be difficult for a manager to turn down.

In an actual example, an operations manager tried to recommend an online chromatograph in the bottoms stream of a naphtha stabilizer column to detect the presence of light boilers due to the malfunctioning of the column. The same safety function can be obtained from the temperature profile of the column, at a much lower cost. Clearly the chromatograph was an instrument of great interest for quality control of the product that (we later confirmed) had been removed in a budget cut during the basic engineering.

Excessively nebulous recommendations, such as “study the possibility of installing a redundant pressure probe.” Not always will the HAZOP group succeed in identifying the most suitable recommendation for protecting an at-risk scenario. In this case, it is definitely acceptable to include a recommendation such as “study what needs to be done in order to … .” On other occasions, there will be two or more divergent opinions and a consensus will not be reached. In this case, the best solution is to include all the possible options, allowing someone outside the group to decide on the best one. However, in all other cases, a recommendation must be clear, specific and not open to interpretation. The adoption of poorly worded actions results in their not being carried out. A similar situation is produced when the wording of a recommendation is excessively open.

At the other extreme is the possibility of trying to resolve the action of the HAZOP to the “nth degree”. In an actual case, one of the participants in the HAZOP proposed calculating the required diameter and practically writing the specification of a safety valve it was being recommended to install. It must be remembered that a HAZOP is a brainstorming exercise in which people from different environments participate and whose time should be respected. The study facilitator/leader should prevent the engineering of safeguards during the meeting. The HAZOP should result in a list of actions, or recommendations, with the designation of someone responsible for carrying them out, but not an engineering design.

Conclusion

The HAZOP methodology, when used appropriately, represents an extremely powerful tool for the identification, semi-quantification, and mitigation of risks in process plants, both continuous and batch or semi-batch. The biggest inconvenience of this technique is its relatively high cost, in terms of the time required of the people who need to participate in the brainstorming sessions. This high cost means that the HAZOP needs to be carried out to optimum effect, avoiding the mistakes listed in this article. Selecting an experienced facilitator is essential to the success of the HAZOP.

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