



FOCUS ARTICLE

Some Common Mistakes in HAZOPs

Author: Dr. Arturo Trujillo, Global Director Process Safety Consulting
Clive de Salis, Principal Process Safety Engineer

Over the past few decades Hazard and Operability Study (HAZOP) has been imposing itself as one of the most powerful tools for identifying process hazards. In addition, with the use of more or less simplified semi-quantification systems, HAZOP is being increasingly used both as a tool for risk assessment and for prioritising actions for risk mitigation. On the other hand, a HAZOP is a time-consuming exercise and should be conducted in such a way as to ensure that the results justify the effort expended in achieving them. In this paper we point out some of the pitfalls that can jeopardise a HAZOP team's task, and the ways to avoid them.

The International standard, IEC61882, is now a European Norm and published by every standards authority in Europe as EN 61882. Since 14th April 2019 all other conflicting standards have been withdrawn leaving EN 61882, 2nd edition (2016) as the standard for HAZOP studies.

Hazard and Operability Study – HAZOP

The advantages offered by HAZOP over other process risk analysis tools are numerous, which includes the following:

- > It has a rigorous character: structured, systematic and comprehensive.
- > It is easy to learn and apply.
- > It is adaptable to the majority of process industry operations.
- > It allows the interchange of the knowledge and experience of the participants.
- > It helps to anticipate potential accidents.

It acts as sort of a training for participating personnel; the participants are looking at the process from another perspective; not “how should it run”, but “how can it fail to run correctly”. Nevertheless, it should be kept in mind that HAZOP is an expensive tool, especially since it requires the dedication of a multidisciplinary team over sometimes extended timeframes. Such a team is made up of people with important responsibilities in the plant being analysed (engineering, maintenance, operations, etc.), who need to juggle with these responsibilities while the HAZOP is being carried out. This significant cost means that the performance of the HAZOP needs to be optimised so as to maximise its possibilities and amortise the investment of time and effort made by the group.

The Gaseous HAZOP

One of the most frequent mistakes is planning. This mistake involves the establishment at the outset, often by neither the HAZOP coordinator nor the team, of a fixed duration of the HAZOP, which must be observed to the letter, even if this means expanding or contracting the HAZOP to fill all the time available for its completion, like a fictitious 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, especially when it may be part of a project schedule, with milestones to be achieved and, in any event, to optimise the participation of the managers of the plant being studied, as indicated above. Nevertheless, we have on occasions attended HAZOP studies whose duration, fixed in advance by people outside the group, made it necessary to limit possible discussion, thereby restricting the crucial brainstorming and reducing the quality of the analysis. On the other hand, we have also witnessed HAZOPs which were extended unnecessarily, with endless discussions of limited value, to fill the time initially allocated, and thereby “justify” the work of the group.

Estimating the duration of a HAZOP is not, of course, an exact science; it requires a good knowledge of the methodology, of the complexity of the process, of the nature of the risks that can be identified up front and, of course, of the idiosyncrasy 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 Poorly Prepared HAZOP

Another too common mistake is not to have available the information required for a HAZOP study. Even worse, to have non-updated or incomplete information. This is especially critical regarding process and instrument diagrams (P&IDs). Experience shows us that trying to facilitate a HAZOP study with obsolete P&IDs becomes a game of “finding the seven errors” instead of the brainstorming focused on the process exercise that 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 flair of 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 Marxist (or Marxian) HAZOP

Under this heading we refer, obviously, to the countless HAZOP studies which have members of the group continuously getting in and out of the meeting room, or taking calls on mobile phones, landlines, walkie-talkies... - in short, HAZOP studies reminiscent of the Marx Brothers’ cabin in “A Night at the Opera”.

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 an industrial plant could depend on it, not to mention the people who work there. Therefore, it is vital for the HAZOP group to be limited in size (ideally six people or fewer, excluding the HAZOP facilitator and, if there is one, the HAZOP secretary). In addition, the group must remain focused; applying at all times the maxim that “in a HAZOP there are no assistants, only participants”. Logically, it will be up to the HAZOP facilitator to schedule the necessary pauses and breaks to guarantee the team’s concentration (we recommend at least one pause every two hours).

So, 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 be able to contribute to the discussion all the information they have available.

At worst, if a good number of participants in the HAZOP are not sufficiently familiar with the plant or process being analysed, then a HAZOP meeting can turn into something completely different, such as a review of P&IDs, or the drafting of a procedures document by committee. Obviously, this is one of the best ways of wasting the HAZOP participants’ time and, what is more, of ultimately arriving at a poor-quality result if, as said earlier, there is a strict time limit for completing the work.

At the other extreme is the HAZOP study without the minimum essential quorum. At the risk of being repetitive, bear in mind that a HAZOP study is a brainstorming exercise and, therefore, requires 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 organisations. Nevertheless, and as a very

general criterion, 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 in the team has any knowledge of these phenomena. If team members do not have this expertise, external specialists can be brought into meeting sessions, as needed (provided they are aware of their own shortcomings!).

The Minimalist HAZOP

Another frequent mistake in HAZOP studies is to restrict the brainstorming exercise which constitutes the basis (and the power) of the method. Of course, various approaches or deviations of 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 an upper bound for the consequences in this node can be easily identified, and these maximum consequences are protected by safeguards. This clearly means that phases of the procedure will be skipped. 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 up front as an argument for omitting any further analysis. Nevertheless, sometimes a non-obvious scenario will be identified, which constitutes the purpose of the HAZOP study, and this is where it demonstrates its power.
- > Carrying out a superficial review of the combinations of keywords 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 go on repeating 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 non-trivial risk scenario is palpable.
- > Carrying out HAZOP studies using some form of prior information: For example, templates, the HAZOP from a similar project, etc. Again, what the HAZOP study is meant to do is analyse 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 prior information. But the obvious risk is to carry out a “cut and paste” exercise, totally alien to the spirit of a HAZOP study carried out correctly.

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

The Bureaucratic HAZOP

An alternative form of the above 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. As is logical, the same deviation generally causes the alteration of more than one process parameter and, therefore, could be entered in more than one place in 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. Again, it is up to the HAZOP facilitator to ensure that the group remains focused on brainstorming rather than limiting itself to regarding the HAZOP table as simply a form-filling exercise.

Safeguards and Recommendations

Safeguards

A large number of problems affect safeguards. Without doubt the most blatant case is to list safeguards which, in reality, are nothing of the sort. The following are some examples:

- > Local instruments which are never checked by field operators and, therefore, could in no way be considered safeguards.
- > Alarms which 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 has to diagnose which of the multiple options he is faced with, thereby losing valuable time for action.
 - Alarms which are activated frequently, often for trivial reasons, and which, therefore, 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 thirteen more 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, when the cause giving rise to the scenario is human error (which presupposes that the procedure has not been followed properly).

Recommendations

Lastly, it is well known that one of the end products obtained from a HAZOP study is a report on actions that should be carried out to improve the safety of the plant or process being studied. As is logical, mistakes can also be produced at the time of writing up the conclusions. The most common ones are:

- > Recommendation incontinence. Some HAZOP groups consider that they have to issue a recommendation for any scenario that has consequences for safety or the environment. 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 duly protected by the safeguards and, only if not, propose recommendations for doing so. 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 for the safety of the plant or process. The use of some system for quantifying risk and categorising acceptable and unacceptable risks, and those for which, therefore, actions need to be taken, helps in particular to avoid such situations.
- > Taking advantage of the HAZOP to write a Christmas present list. Incredible as it may sound, this is a situation that arises quite frequently. Sometimes people will try to use a safety-oriented HAZOP, in which it will therefore be difficult for a manager to turn down recommendations on economic grounds, to try to recover, in the form of a recommendation, some operational or plant design improvement which has been ruled out in earlier stages on the specific grounds of high cost. In an actual example, an operations manager tried to recommend an online chromatograph in the bottoms stream of a naphtha stabiliser column to detect the presence of light boiling substances 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 which (we later confirmed) had been removed in a budget cut during the basic engineering.
- > Excessively lax recommendations, such as “study the possibility of analysing the advisability 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 such a 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 for 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 “weakly” worded actions results in those actions ultimately not being carried out. A similar situation is produced when the wording of a recommendation is excessively open.
- > At the other extreme of the above problem 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 not be wasted with actions that only one of the participants can resolve subsequently in the peace and quiet of his office. 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.

Summary and Conclusions

The HAZOP methodology 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 of the people who need to take part in the

brainstorming sessions. This high cost means that the HAZOP needs to be carried out to optimum effect, avoiding the sorts of mistakes which have been listed in this article. It is the responsibility of the HAZOP facilitator to make sure the group does not commit any of these mistakes, so the selection of an experienced facilitator is an essential element for assuring the success of the HAZOP.

DR. ARTURO TRUJILLO

Dr. Arturo Trujillo is currently Global Director of Process Safety Consulting. He worked for 25 years in several consulting and engineering companies before joining DEKRA in January 2012. His main areas of expertise are diverse types of process hazard analysis (HAZOP, What-if, HAZID...), consequence analysis and quantitative risk analysis. He has facilitated more than 200 HAZOPs over the last 25 years, especially in the oil & gas, energy, chemicals and pharma industries. He is based in Barcelona (Spain) and can be contacted at arturo.trujillo@dekra.com.



CLIVE DE SALIS

Clive de Salis is Principal Process Safety Specialist and consultant in process design safety, critical instrumentation and hazards. He writes both the IEC62443 series of standards on Cyber security and the IEC61508 series which includes IEC61511 on SIL rated systems. His main areas of expertise are process risk assessment, including HAZOP, with extensive experience in the design and installation of safety systems and determination of safety integrity levels. He is also an expert witness to UK Courts. He can be contacted at clive.desalis@dekra.com.



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To contact us: dekra-ops.uk@dekra.com

To contact us: +44 (0) 23 8076 0722

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