IDENTIFYING NEW RISKS

Keith Baisden, ABB Consulting, UK, explains the role of risk assessment methodology in assuring process safety in the oil and gas sector.

For many years full retrospective HAZOPs have been undertaken for upstream and downstream oil and gas assets in order to revalidate their safe operation. The main reason for revalidation is that circumstances change and in general the understanding of hazards also increases. HAZOP, originally intended for capital projects, is now specifically mentioned in the USA's Process Safety Management regulations, reflecting its position as a best practice approach for risk assessments, including its application to...
### Table 1. Why reHAZOPs identify new risks

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Explanation</th>
<th>Typical examples</th>
<th>Learning/solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plant modifications</td>
<td>Poor or no HAZOP as part of management of change (MOC). Plant documentation not</td>
<td>Better use of MOC procedures.</td>
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<tr>
<td></td>
<td></td>
<td>updated</td>
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<td>2</td>
<td>Changes in operating conditions</td>
<td>Over/under pressure case changes. Low temperature blow down cases. Outside</td>
<td>Applicability and better use of MOC procedures.</td>
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<td></td>
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<td>piping/equipment design basis.</td>
<td></td>
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<td>3</td>
<td>Changes in the way the plant is operated</td>
<td>Different start up/shut down sequences. Plant operating procedures not updated.</td>
<td>Applicability and better use of MOC procedures.</td>
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<td></td>
<td></td>
<td>Changes in manning levels/locations.</td>
<td></td>
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<tr>
<td>4</td>
<td>Plant not built as per HAZOPed design</td>
<td>Positioning of isolation valves. Sizing of CVs/valves/NRVs. Pipe sizes/lengths/</td>
<td>Project management procedures and use of Hazard Studies 4 and 5 (Pre startup safety</td>
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<tr>
<td></td>
<td></td>
<td>bends. Pump sizes. Equipment fireproofing insulation. Layout, access, etc.</td>
<td>review (PSSR) during project execution.</td>
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<tr>
<td>5</td>
<td>Original HAZOP actions not completed</td>
<td>Failure to close out actions and validate their completion. Potential for unclear</td>
<td>Project management procedures and use of Hazard Studies 4 and 5 during project execution.</td>
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<td>responsibility between EPC and owner.</td>
<td></td>
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<td>6</td>
<td>Plant deterioration</td>
<td>Degradation of plant integrity or performance, such as: corrosion, erosion,</td>
<td>Periodic review of plant condition against basis of safety case assumptions.</td>
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<td>fatigue/creep, reliability, housekeeping, etc.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Changes in standards</td>
<td>New corporate requirements/expectations. Different design standards, new legal</td>
<td>Clarity needed on which requirements are retrospectively applicable.</td>
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<td></td>
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<td>requirements etc.</td>
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<td>8</td>
<td>Increased awareness of pressure relief</td>
<td>Gas breakthrough. Flow through CVs and/or bypasses. Multiphase flow case. Fire</td>
<td>Better guidance/checklists during initial design. Better guidance for initial HAZOP</td>
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<td></td>
<td>scenarios</td>
<td>relief case. Vacuum relief case identified.</td>
<td>teams. More involvement of experienced operators.</td>
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<tr>
<td>9</td>
<td>Adequacy of flare and blowdown systems</td>
<td>Sizing of flare systems. Combinations of events. Mechanical robustness of flare</td>
<td>Better guidance/checklists during initial design. Better guidance for initial HAZOP</td>
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<td></td>
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<td>systems. Surge events (e.g. potential for HE guillotine fractures).</td>
<td>teams. More involvement of experienced operators.</td>
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<tr>
<td>10</td>
<td>Plant incidents</td>
<td>Increased awareness of risk, due to knowledge of: near misses, operating experience,</td>
<td>Better sharing of incidents across operating companies and sectors.</td>
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<td>accidents, releases, fire, etc.</td>
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</table>

Existing facilities (reHAZOPs), typically carried out every five years. Guidance is provided both within BS IEC 61882 and the IChemE Guide.

A key part of assuring process safety is an effective response to recommendations arising out of reHAZOPs, or other safety reviews. This article describes some of the conclusions drawn from reviewing a sample of reHAZOP recommendations, and the subsequent outcomes from implementing these recommendations. For instance, why some hazards were not picked up in earlier hazard studies and why there is a difference between the expected and actual actions that result from implementing HAZOP recommendations.

## HAZOPs versus reHAZOPs

To start to understand the background to new, previously unidentified risks becoming apparent it is useful to compare a HAZOP carried out during the initial design stage, usually as part of the project, with a retrospective HAZOP carried out on an operating asset.

Normally the original Project HAZOP Team is larger and has better knowledge of the original design intent and standards, the reHAZOP team benefits from operating knowledge, experience of previous incidents and the awareness of human factors.

A list of examples of why retrospective HAZOPs identify new risks, not previously detected, is included in Table 1.

The new risks identified in reHAZOPs can be considered as falling into one of three broad categories: risks arising from some form of change, risks introduced between completing the original HAZOP and commissioning or risks arising from omissions in the original study.

Changes to an operation will always occur, so new risks will constantly be introduced into that operation. The challenge is to have robust systems, including management of change (MOC), that identify, evaluate and manage all new risks at the point of introduction. The robust application of standard MOC systems should cover many of the changes; plant modifications are the most well covered type of change, changes to operating conditions and operating practices are also covered by many MOC procedures. Changes arising from plant...
management, sharing learning etc. it is highly likely that new risks will arise between periodic reHAZOP studies. So reHAZOP acts as a necessary 'safety net' to catch new risks. Experience shows that the studies always find new risks, often significant ones.

On top of identifying new risks as they arise a further area of good practice is to update the original HAZOP record to create an ‘evergreen’ risk assessment that provides the live view of operating risks. This evergreen record makes future reHAZOPs and other safety reviews, such as thorough reviews of offshore safety cases, much more efficient as the information is readily available for review.

Expected outcomes from HAZOPs
The purpose of a HAZOP is to identify hazards, not to engineer solutions. An effective HAZOP team will focus on addressing the hazards and not try to design the solution to the problems identified.

Best practice suggests that HAZOP recommendations, as well as being risk ranked, should be classified with the expected outcome. There are two main reasons for this: to assess the potential resource requirement to close out these actions and to assist in prioritising. As an example, simple updates of operating procedures may require minimal effort for significant gains in risk reduction.

ABB Consulting generally uses nine categories to classify HAZOP recommendations:

- Information need.
- Procedure review/update.
- Design check.
- Hardware changes including instrumentation.
- Safety integrity level (SIL) determination.
- Maintenance procedures, inspection and testing.
- Risk assessment or specialist review.
- Piping and instrumentation diagram (P&ID) check/update.
- Training.

For the purposes of this article and the ease of comparison with the final outcomes, the expected outcome from the HAZOP team recommendations have been allocated against one of four categories: clarification study, design review, documentation check/update and modification required.

A typical spread of recommendations, against the above classification, can be seen in Figure 1.

Outcome from recommendations
With reference to Figure 1, the review of actual outcomes (i.e. after completing study recommendations), compared with expected outcomes, initially identified that a reasonable number of recommendations (10%) had actually been rejected.

There are legitimate reasons why a HAZOP recommendation may subsequently be rejected. The analysis may contain material factual errors, the recommendation may not be necessary to protect personnel, or the equipment may be out of service.

In order to better understand the impacts of the actual outcomes, from implementing recommendations, these outcomes have been allocated against one of six categories as follows:

- Document updates.
- Major modification: hardware change, outage requirement, pressure relief verification.
- Minor modification: set point changes, field tagging, minor repair.
- Procedural changes.
- Rejected.
- No further action required.

A typical distribution of recommendations, against this classification, can be seen in Figure 2.

From Figure 2 one can see that half of the originally recommended actions ultimately required further work to close out the action. The other half were closed out with no further work required. The major benefit resulting from this category will be an increased awareness and understanding by the operations team and HAZOP team members who raised the concern in the first instance.

Notably, approximately 31% of the original recommended actions resulted in the need for modifications, of which approximately 19% were major.

The percentage of recommendations actually resulting in document upgrades was the same (7%) as predicted by the HAZOP team, however, the actual distribution of these was different from expected.

Conclusion
Based on this analysis one can see that significant effort is involved both in carrying out a HAZOP and then subsequently closing out all arising actions. Also, 50% of the recommended actions required further work before they could be closed out.

The benefits of reHAZOP studies are illustrated by the identification of significant numbers of new hazards. These new hazards arise for a variety of explanations, all of which occur frequently in the hazardous process industries.

It is important to note that the risks identified during HAZOPs are not reduced until the action is ultimately closed out.

Further benefits from HAZOPs include an increased general awareness of the process safety aspects of the facility, which is beneficial when assessing future modifications or incident investigations and in support of regulatory compliance.

References
3. USA Occupational Safety & Health Administration Standard 2910.119, Process safety management of highly hazardous chemicals.
deterioration are normally managed well if robust asset management systems are in place. The area that is generally not so well covered is where changes arise from increased knowledge or learning. This is the case in learning from incidents, be that within a facility or on a global level, or where the industry’s knowledge of a particular topic moves on.

New risks are also introduced before production start up, when either the actions from the original HAZOP are not adequately completed or when the design is altered after the HAZOP and the changes not controlled. These risks should be controlled by robust project management processes, procedures and controls.

The risks arising from omissions occur because the original study team ‘missed’ something; failed to identify a hazardous scenario, underestimated the potential consequences, underestimated the likelihood of occurrence etc. Trying to minimise omissions is clearly important and relies on a number of factors including; the experience and rigorous approach of the leader, the knowledge of the team, the time allowed for the HAZOPs, the level of independence of the HAZOP leader from the project manager, the availability of specialist input and vendor knowledge, the pressure (directly expressed or implied) on the team to complete studies quickly, the operational experience accumulated in the process being reviewed, the methodology used and the state of the design.

This discussion illustrates the great difficulty in getting a comprehensive risk assessment for a new project and the even greater difficulty in maintaining the risk assessment. Even with excellent and robust management systems for MOC projects, asset

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