Diving deeper

What more can you do if your company displays good process safety performance? Plenty, says Graeme Ellis
YOU are responsible for process safety on a number of global sites and have just reviewed the results of the latest annual process safety management (PSM) audit. If your PSM audit summary looks something like that shown in Figure 1, year-on-year improvement with no significant issues, and very few recommendations for improvement, then it’s good news – isn’t it?

Assuming you have a robust audit programme, then finding no issues during audits appears good news, but if you want to improve performance further then what more can you do? You may also be finding that leading process safety performance indicators (see Figure 2) are not consistent with the audit performance, and the lagging indicators are showing a worrying trend with the number of process safety incidents (PSIs) not improving or they may even be increasing. If you aren’t looking at the right issues on an audit, then it won’t improve the number of PSIs.

limitations of conventional
PSM audits

Many organisations, when they seek assurance that process safety is being managed appropriately, base their analysis on detailed auditing of the PSM system. However, process safety incidents are usually caused by failures of multiple barriers. The potential interactions between barriers are often not visible at the PSM system level, which consists of distinct generic elements, for example mechanical integrity, incident investigation, management of change, and so on. Auditing PSM system elements may not therefore identify the potential for a process safety incident, which requires assessment of specific accident scenarios and verification of specific barriers.

delving deeper

Based on our experience, some major global companies (who we can’t name, for confidentiality reasons) are adopting a ‘deep dive’ audit approach for each of their sites, which focuses on the barriers associated with a few major accident scenarios, aiming to confirm the following:

- major accident scenarios have been identified;
- safety basis is robust and ALARP;
- barrier design provides the required risk reduction;
- barriers are installed as per design;
- barriers are maintained and tested to ensure effectiveness; and
- personnel are competent to operate and maintain the barriers.

This approach provides rigorous assurance that a particular scenario has sufficient

Figure 1: PSM audit actions

If your PSM audit shows a year-on-year improvement, should you celebrate the success of your PSM programme or feel uneasy that performance has reached a plateau, and maybe a serious accident is just round the corner? This is a dilemma that many global organisations are starting to face.

Figure 2: API process safety pyramid

A simple summary of the main differences between the two types of safety audit illustrates how the ‘deep dive’ identifies the major accident scenarios and places each element under scrutiny.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Conventional PSM audit</th>
<th>Deep dive audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>All PSM system elements</td>
<td>Major accident hazard scenarios</td>
</tr>
<tr>
<td>Objective</td>
<td>Achieve best practice for individual elements</td>
<td>Ensure specific risk control barriers are working effectively</td>
</tr>
<tr>
<td>Focus of audit</td>
<td>Suitability of and adherence to written procedures</td>
<td>Weaknesses in plant, process or people aspects of barriers</td>
</tr>
<tr>
<td>Method</td>
<td>Check completeness of documents and test experience with system owner and users</td>
<td>Verify effectiveness of barriers based on plant records, understanding of staff, and field observations</td>
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</table>
A field visit to verify specific barriers is an essential stage of the audit. The first requirement is a visual check that barriers are installed as designed, and that the equipment is in good condition. Photographs of any deficiencies provide high-impact evidence to site management.

**Methodology**

Initially the potential for major accidents is identified by discussing and reviewing any existing process hazards analysis documents, for example HAZID reports, or safety reports. This stage allows an understanding of major accidents and the required barriers, but more importantly selects a range of high-risk scenarios for the detailed deep dive audit.

The selected scenarios should cover a range of event types, allowing different types of prevention, control and mitigation barriers to be assessed.

The next stage considers each scenario and the associated barriers, seeking verification that these are functioning effectively. The focus of the deep dive involves barrier verifications relating to plant (reliability of equipment), process (effectiveness of procedures), and people (competency of staff in key roles).

The audit is best conducted by two specialists: one with a process safety and operations background, and the other with plant engineering and integrity management background. In addition to the audit team, it’s very important to involve process engineers, operating managers and maintenance engineers from the site. This helps site management to understand major accident scenarios, and ensures that the audit team can efficiently locate key information.

The audit report provides details of the assessment for each barrier, with the decision on whether the barrier is working effectively or whether a weakness related to plant, process or people needs to be addressed. The weaknesses can be specific to this scenario and barrier, or systemic such as lack of proof testing for safety instrumented systems. In some cases the audit may reveal insufficient barriers and a recommendation may be raised for further risk assessment or specific barriers to be implemented.

A field visit to verify specific barriers is an essential stage of the audit. The first requirement is a visual check that barriers are installed as designed, and that the equipment is in good condition. Photographs of any deficiencies – such as holes drilled through bund walls – provide high-impact evidence to site management. Figure 3 shows a gas plant isolation valve that was designed to be kept open to prevent potential overpressure of the line. This valve is specified as ‘lock open’ in the design, but was found during the field visit to have no lock in place. This specific issue can be addressed but the finding indicates a potential systemic issue with locked valve controls.

Field visits also provide the opportunity to discuss barriers with operators and maintenance technicians. This tests their understanding of the potential for major accidents on the site, and their role in maintaining the barriers. It’s common to find operators who don’t know the emergency procedures and actions they need to take to prevent incidents from escalating. For example, a loss of eco-toxic material into the drains system may require closure of a manual valve on the site outfall line – but the operator may not know that, nor the location of the valve. These discussions provide a more general insight into the on-site understanding related to major accidents,
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and may indicate some complacency towards process safety.

conclusions
As the deep dive audit is in-depth and can take a significant amount of time to assess a single scenario, it requires selection of the high consequence major accident hazards for the site. Unlike conventional PSM audits the findings are at a detailed level, and can benefit not only the scenarios being assessed, but many similar scenarios by discovering weaknesses in the generic risk controls. For example, the findings that a relief system has used an out-of-date sizing method may result in an action to look at a number of similar pressure relief systems.

Although the scope of the deep dive audit is limited when compared to a conventional PSM audit, it should be clear that this approach provides a high degree of confidence that barriers are working effectively. When conventional systems-based audits are starting to find very few actions, the extra level of rigour provided by a deep dive is well worth considering.

Companies are choosing to carry out deep dive audits across several global sites in order to provide a quick snapshot of performance, and to benchmark sites in order to identify those requiring greater senior management attention.

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Chemical Engineering Matters
The topics discussed in this article refer to the following lines on the vistas of IChemE’s technical strategy document Chemical Engineering Matters:

Health and wellbeing Lines 11, 12, 13

Visit www.icheme.org/vistas1 to discover where this article and your own activities fit into the myriad of grand challenges facing chemical engineers.

The familiar ‘Swiss-cheese’ model illustrates how, under certain circumstances, even multiple barriers against runaway reactions could still result in a major accident.