A BENCHMARKING STUDY ON ASSET INTEGRITY AND THE ISSUES OF AGEING PLANT IN THE UK CHEMICAL INDUSTRIES

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Guidance on best practice for Process Safety Management is growing in abundance but in general the high hazard industry's approach to the subject has been somewhat disjointed. In order to address this, HFL Risk Services, together with the Chemical Industries Association and the National Skills Academy for the Process Industries embarked on what was the first ever Process Safety Management benchmarking programme for UK COMAH sites.

The benchmarking exercise, which had the support of the HSE, involved representatives from 12 COMAH-regulated sites of differing size, from multinationals to SMEs, with different areas of specialism. The aim of the programme was to benchmark current practices, share experience between companies, find commonality and help sites to strike a practical balance between aspirations, standards and reality.

The focus of the benchmarking programme was Asset Integrity Management since this is a cornerstone for continued safe operation and a topic that is of growing concern for the UK regulatory authorities. Since completing this initial programme of work, further benchmarking studies have been carried out at other hazardous installations both in the UK and overseas. The additional data was consistent with that obtained from the first phase, showing that national boundaries had little impact on the overall findings and conclusions.

The auditing process is based around current guidance produced by the US Center for Chemical Process Safety (CCPS) and has been prepared independently of, but mapped to, COMAH guidelines. A scoring system has also been developed to allow assessment and prioritisation according to the POPMAR model set out in HSE's guidance document HSG65.

It was clear from the results that although there were several instances of world class performance in terms of Process Safety Management, there were weaknesses in some areas, most notably Process Safety Leadership and approaches to Continuous Improvement. By not having clear policies and effective monitoring and review processes in place, companies are allowing themselves to be regulated into rather than setting out their own programmes for management of process safety.

This paper examines the key observations from the benchmarking programme, their implications for the chemical industry as a whole and provides examples of best practice in implementing and sustaining Asset Integrity Management Programmes.

WHY BENCHMARK?

Many years of auditing and assessment at different chemical sites to produce COMAH Safety Reports had led HFL Risk Services to the conclusion that, on the whole, industry's approach to Process Safety was lacking coherence. This was despite the fact that there is an abundance of guidance on best practice in this area and the related subjects.

A benchmarking programme would allow companies to see how their own current practices with respect to Asset Integrity compared with industry best practice guidelines; identify areas for improvement; and find out how their results compared with those of their industry peers.

Additionally, the exercise would encourage shared experience between companies, find commonality across the board and help sites to strike a practical balance between aspirations, standards and reality. It was intended that the results from the programme would be used to inform Process Safety Management (PSM) policy for both the participating group and the chemical industry as a whole.

THE FOCUS

PSM is an extremely wide ranging topic, so for this benchmarking activity it was decided that the main focus should initially be on a single aspect – Asset Integrity Management – with particular emphasis on the arrangements in place for prevention of loss of containment. The reasons for this were twofold.

Firstly, the reports following the Buncefield (Buncefield Major Incident Investigation Board, 2008) and Texas City (Baker JA, 2007 & U.S. Chemical Safety and Hazard Investigation Board, 2007) investigations both recognised inadequate maintenance and testing as a contributing factor to the ensuing accidents and so it would be helpful for companies to know how they stood against their peers and best practice, allowing improvements to be readily identified and made where appropriate.

Secondly, UK operating companies are being placed under ever increasing pressure to deliver competitively-priced products in the face of fierce global competition. Unless there is a major change in market conditions, it is

likely that many companies will have to continue operating plant beyond its planned retirement date, seemingly adding to the problem. However, where the inspection, maintenance and repair strategies are well matched to the equipment and duty, there is no reason why extended service should impact on safety. It is therefore important for them to understand how cutbacks on investment and personnel could have potentially deleterious effects of one of their key risk control systems.

WHO TOOK PART IN THE BENCHMARKING PROGRAMME?

Representatives from 12 COMAH-regulated complex chemical manufacturing sites took part in the initial programme, which comprised: a group introductory day outlining the aims and objectives of the benchmarking programme; training and workshop activities in PSM; individual site assessments; report generation; and interactive group feedback sessions.

The organisations ranged in size from large multinationals to SMEs, each with differing areas of specialism. All bar one were COMAH top-tier sites and the companies involved were specifically selected to give a fair representation of the UK chemical industry and the challenges it faces with regard to PSM.

Assessments were later carried out at a further five hazardous installations in the UK and Europe, three of which are regulated under the Seveso Directive. The additional data obtained from the European sites supported the initial findings and it was encouraging to see that the conclusions drawn were not unduly influenced by the transition across national boundaries.

ASSESSMENT RATIONALE AND METHODOLOGY

Pressure systems are already subjected to specific legislation, requiring routine examination by a Competent Person, but other process systems not covered by this regime may present even greater risks to people on and off site, such as those containing large inventories of toxic or highly flammable substances. Remaining cognisant of this, plant operators must avoid working in 'compliance mode' and look beyond the boundaries of specific regulations to see what more can be done to ensure the mechanical integrity of their containment systems is maintained.

When developing an inspection and maintenance programme one must be aware of those items of equipment that are susceptible to deterioration or damage. Storage tanks, for example, can suffer from either internal or external corrosion. This can cause the walls to become thin and leaves them open to the increased possibility of cracking. Thin walls can also relent on account of mechanical damage such as denting.

Similarly, the very devices that are designed to protect equipment against overfill or over/under pressure are not immune to failure and should always be included in inspection regimes, with inspectors paying close attention to aspects such as moisture ingress, fouling and calibration inaccuracies.

However time consuming and laborious, assessing plant and equipment degradation is an essential process and should be undertaken by a team of competent and experienced engineers and operations personnel.

Simply put, Asset Integrity Management is about ensuring that the design intent for the process 'system' is maintained over the operating life of the plant. This requires appropriate arrangements to be in place for on-going inspection, maintenance and repair, tailored to the conditions of service and degree of hazard posed by the process fluids. As a rule, even basic schemes of examination should be put together using the following simple steps:

1. Registration – register all assets, you need to know what you have before you can inspect it
2. Categorisation – assess the consequences of failure, they are not the same for all systems
3. Assessment – understand how, where and when failures are likely to occur
4. Documentation – record the outcomes of assessments in a structured way
5. Inspection – inspect things correctly, at the correct place and in the correct way

As a minimum an examination scheme should stipulate all of the components within the process system. It should state which parts of the system are to be examined and which are not. The type of examination required should also be specified and reference should be made to relevant procedures, including inspection and testing to be carried out on any protective devices. The minimum frequency of examinations should also be fixed.

More complex schemes may need to include elements addressing the preparatory work needed for the plant items to be examined; any special requirements relating to the remnant life of equipment; modified inspection frequencies based on PHA and history; etc.

Inspection should not just be left to the technical experts, however. Perhaps the simplest forms of inspection are regular 'eyes on' type inspections, which can identify many of the issues at an early stage before they are allowed to escalate into a catastrophic failure. For example, you don't need expensive thermographic surveys to identify poor insulation if there are weeds growing out of lagging – this is a good indication of water ingress issues.

But ultimately, responsibility for safe operation rests with the board of directors and senior management of the company and it is they who must demonstrate that appropriate standards are being maintained.

Assessment exercises, facilitated by HFL Risk Services using the company's INSIGHT Lifecycle® audit tool, were undertaken at each of the sites between November 2010 and December 2011. INSIGHT Lifecycle® comprises a series of question sets and model answers aligned to current legislation and best practice guidance. Responses are scored against model answers, taking into consideration the four P's of process safety (the Process, Plant, Procedures

and People) to pinpoint and prioritise management system deficiencies.

The assessment process used here was based around current guidance produced by the US Center for Chemical Process Safety (CCPS, 2007) and has been prepared independently of, but mapped to, COMAH guidelines (HSE, 2006). The scoring system also allows assessment according to the POPMAR model set out in HSE's guidance document HSG65 (HSE, 1997), i.e. against Policy, Organisation, Planning & Implementation, Monitoring, Audit and Review.

For the purposes of this exercise, assessments were restricted to consideration of arrangements in place for inspection and testing to prevent loss of containment, giving due consideration to plant (equipment), procedures (documented and 'custom and practice') and people (allocation of appropriate resources). In all, over 200 data points at each site were collated and analysed, giving over 3,500 data points in total on which to base the results. At each site a cross-functional team of managers, supervisors and operatives was involved to ensure that all pertinent elements of the operation were addressed and that scores represented the views of the companies involved, and not those of the assessors. The information generated was supported by observations and documentation as appropriate.

GENERAL OBSERVATIONS

The benchmarking process unveiled some encouraging results, including instances of world class performance in terms of PSM systems. Certainly the scoring was high for many of the technical aspects associated with Asset Integrity Management. Responsible Engineers were found to be competent in their areas of expertise, having a sound knowledge of what needed to be done day-to-day to maintain integrity and undertaking it with aplomb. So in terms of the POPMAR model, the Organisation, Planning & Implementation, and Monitoring aspects were relatively strong, indicating that operators are doing what needs to be done in practice and in many cases doing it well.

Results were not so encouraging when the companies were benchmarked against the other elements of POPMAR, namely Policy, Audit and Review, however. Aspects relating to Leadership and Administration were found to be wanting, emphasising an over- reliance on engineers and a lack of understanding/input at board and senior management level. Seven years on, this observation is consistent with the findings and recommendations in the Baker Panel Report (Baker JA, 2007) and the CSB's Investigation Report following BP Texas City (U.S. Chemical Safety and Hazard Investigation Board, 2007) – *boards of directors must exercise their duty to ensure that the highest standards of safety are met*.

Interestingly then, but perhaps not surprisingly, the scores across all companies were higher in those areas where more prescriptive legislation exists, such as compliance with the Pressure Systems Safety Regulations (PSSR). Safety Instrumented Systems (SIS) also scored well; no doubt because of the existence of clear and structured guidance such as the European standards for functional safety (British Standards, 2004), and a continued push from the regulator.

Performance tailed off however, to differing degrees, for lower risk non-codal systems. For example, it transpired that greater opportunities for improvement were to be found in the inspection and testing of pipework, principally in medium and lower risk process systems. Similarly, secondary and tertiary containment systems fared less well. Other factors such as the control of maintenance spares in relation to critical systems were also highlighted.

Inspection of structures was another topic for some discussion, specifically the way that items such as hangers, drains and flooring should be evaluated as part of a structural survey. Redundant structures should also form part of the same survey especially where failure could be a precursor to a major accident.

As far as actual procedures were concerned, most participants scored more highly in design, inspection, mechanical and C&I maintenance, and maintenance planning, with management of change and failure reporting, scoring particularly well. Policy, specifically with regard to asset integrity, identification of critical equipment and assessment of degradation mechanisms, on the other hand, could be improved upon against the guidance.

Scores for the people aspects were general high across the board, which is consistent with the composite scores for the Organisation and Planning & Implementation aspects considered earlier. Questioning on people centred on their awareness, knowledge and use of applicable standards in design and installation, and especially in determining appropriate inspection, testing and maintenance tasks. Scores were higher where the requirements had been captured in site procedures so that access to, and detailed knowledge of, the original source standard was not necessary on a routine basis.

The need for appropriate qualifications for both staff and contract personnel involved in inspection activities was also examined. Scores were higher where certification was in line with standards but training and experience in lieu of some certification requirements was recognised, and systems in place for monitoring adherence to accepted working practices were also taken into consideration.

SUMMARY OF OBSERVATIONS AND AREAS FOR IMPROVEMENT

In summary, the general observations were as follows:

In the absence of clear polices, some companies are falling into 'compliance mode' and failing to set out clear objectives and targets for their Asset Integrity Management programmes. This means that resources are not necessarily being directed to where they might be most needed for the business as a whole and little can be gleaned from Monitoring, Audit and Review. Policy deployment helps to bring all this together by providing a sustainable structure or framework to work to. The formalisation of procedures in this way obviates the reliance on individuals and helps build resilience into the programme overall.

Figure 1. Combined scores against POPMAR model

EFFECTIVE POLICY DEPLOYMENT

As the benchmarking study showed, the development and deployment of policy is central to an effective PSM or Asset Integrity Management programme. The goal of a policy deployment system is to provide a highly visible and open system that allows any individual within an organisation to see which activities are being undertaken in order to meet strategic company plans.

In the case of Asset Integrity Management, the policy statement should set out the key principles governing the programme, stating clearly the organisation's regulatory and corporate requirements. In addition to meeting the requirements of specific regulations, the policy for COMAH sites should cover inspection, testing and maintenance of all equipment containing hazardous materials and any safety or utility systems that help prevent or mitigate the effects of a catastrophic release of those materials, or a sudden release of energy. Ideally the policy should also set out the company's approach to tolerance of risk and use of risk assessment for identification of critical equipment, taking into consideration other types of loss, for example, business interruption, long-term harm to the environment and loss of

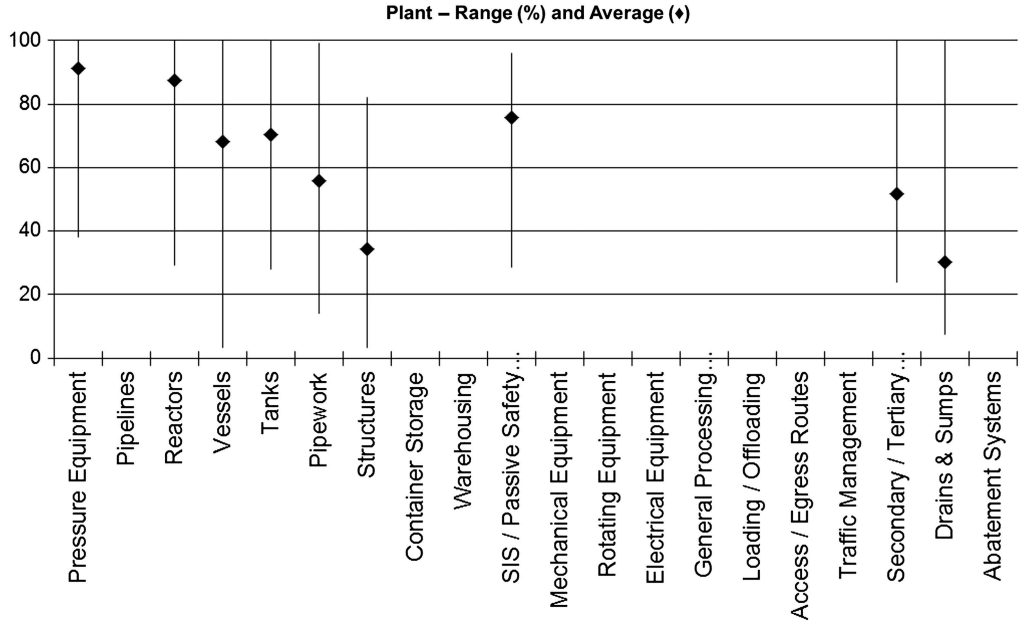

Figure 2. Group scores against equipment class

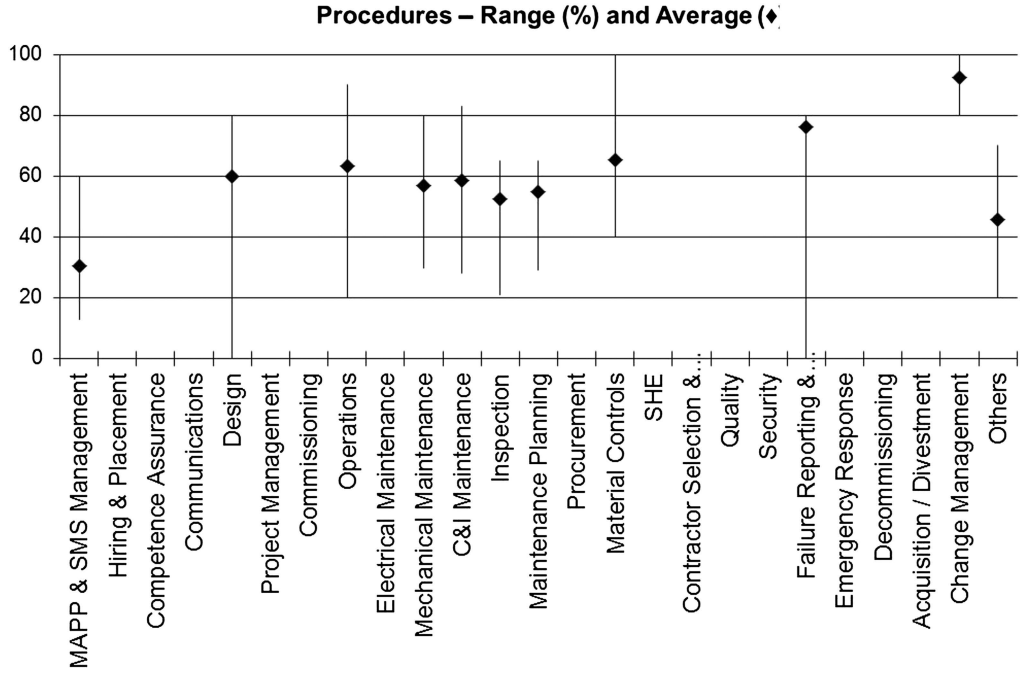

Figure 3. Group scores for use of procedures

good will within the community. Finally, the policy should assign specific responsibility for all activities associated with delivery of the programme. Only by doing this can the company achieve management alignment against corporate targets and objectives.

Having created alignment, senior management must be able to review progress, quickly and effectively, against meaningful measurement metrics (key performance indicators). If correctly implemented, this arrangement will allow individuals to see how progress against their own objectives

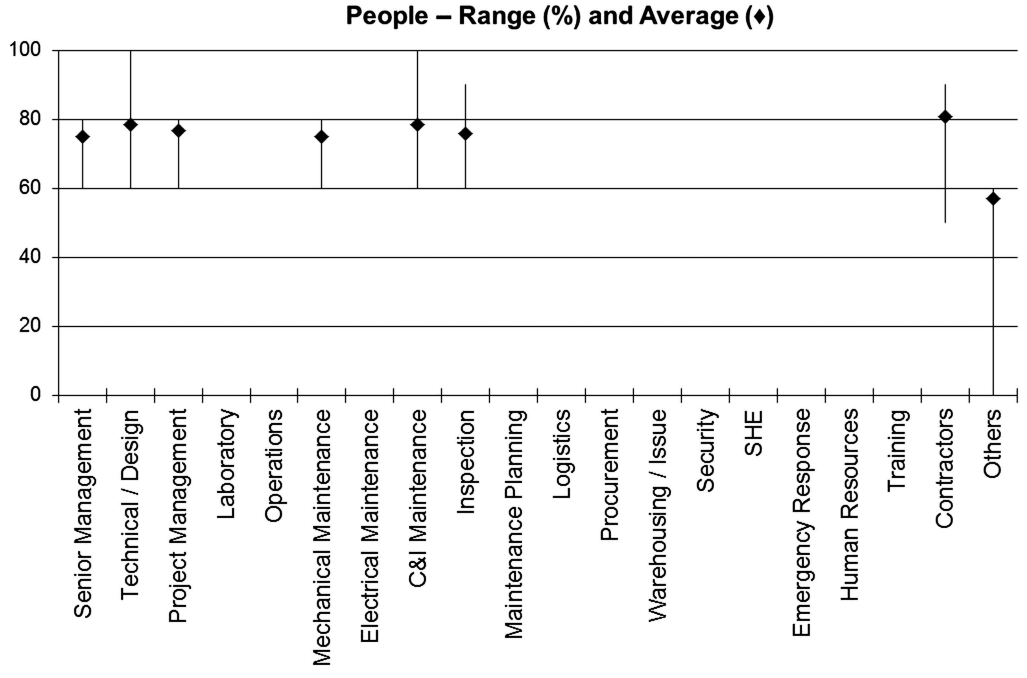

Figure 4. Group scores for use of appropriate resources

Table 1. General Observations

POPMAR	GENERAL AREAS FOR IMPROVEMENT
Policy	• Require specific policies covering Asset Integrity Management • Policies to set out own programmes of inspection, testing and maintenance aligned to standards, risk and business case, rather than allowing them to develop through regulation/interventions by the regulator
Organisation	• Roles and responsibilities to be clearly defined, setting resources and competency requirements • Improved company/facility standards to provide greater transparency and avoid over reliance on individuals
Planning & Implementation	• Registration and identification of critical equipment (i.e. other than pressure equipment and safety instrumented systems) based on risk, e.g. main plant items, piping, supports etc. could be improved • Improvements required in the inspection and testing of secondary and tertiary containment systems • Hangers, drains and flooring need to be evaluated as part of a structural survey, this is not always the case • Control of maintenance spares for critical systems could be improved • Handover to operations following maintenance could be improved in some cases • Redundant structures should be included in structural surveys especially where failure could be a precursor to a major accident
Monitoring	• Information from inspections not always reviewed and acted upon • KPIs used to monitor effectiveness of programmes but not in all cases and not always visible throughout the organisation
Audit	• Generally, audits do not systematically examine all aspects of the programme, i.e. in scope and depth, to provide meaningful information for review
Review	• Reviews do not consider whether or not the programmes are delivering what the business needs in all cases

contributes to the wider aims of the business. By way of example, deployment of process safety metrics could involve:

Organisational Metrics – based upon corporate goals these metrics will reflect common process safety system elements designed to prevent all forms of loss. These would be standard across all installations within an organisation.

Site Metrics – these will be specific to each site/installation showing the condition of the risk control systems in place to prevent a major accident/incident, e.g. staff competencies, asset integrity management and emergency arrangements.

Plant Metrics – these metrics are based upon what could go wrong resulting in a major accident/incident. They show whether specific processes within the plant are operating as originally intended or not, e.g. progress against inspection plans, adherence to permit to work systems, failure of protective devices in service, etc.

Equipment Metrics – these should provide very specific information focused on the individual risk control systems critical to the safe operation of that equipment, e.g. adherence to equipment specific procedures for loading/offloading, etc.

CONCLUSIONS

The overarching theme that emerged as a result of the benchmarking process is that there is generally a lack of detail in high level policies covering Asset Integrity Management. The issues around the specifics of pressure equipment and safety instrumented systems are well understood and, in the main, well managed. But by not having clear polices in place for other aspects, companies are allowing themselves to be regulated into rather than setting out their own programmes of testing and inspection.

The high scores were consistent with HSE hot topics. But the impetus to improve performance in non-codal areas must come through leadership in individual companies if they are to avoid falling into the reactive compliance trap. Self-regulation, led from the top, gives sites greater clarity on *what* needs to be done, *where* and *when*, in accordance with budgets to achieve business aims.

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