THE CHALLENGE OF DEALING WITH RECOMMENDATIONS FROM SAFETY REVIEWS OF EXISTING ASSETS

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An increasing number of assets across most process industry sectors are now operating beyond their original anticipated design life, potentially in an operational and regulatory environment for which they were not originally designed. In the difficult economic environment that we face, this trend is set to continue. Operation of assets under these circumstances presents additional risks; due to the effects of ageing and the possible existence of deterioration mechanisms that were not foreseen at the time the process was designed. This creates a strong incentive for a periodic, thorough review of process hazards.

A number of techniques are in use including repeat-HAZOP (hazard and operability study), HAZOP revalidation, repeat HAZID (hazard identification) and Process Hazards Review (PHR). Regardless of the technique employed, these studies invariably produce large numbers of recommendations. Such recommendations can require modification of the process, further technical study or changes to procedures, maintenance routines or inspection regimes. Study teams disperse after the exercise leaving a large work load on an already-burdened site team. There may be site or corporate deadlines to meet for action completion or regulatory pressure to implement improvements in a timely way because, until implementation has been completed, the benefits of the study will not be realised.

This paper will address the different challenges of dealing with hazard study recommendations, which include the interpretation of requirements, the need for multi-functional resources to address them, the collation of an ALARP (as low as reasonably practicable) justification and selection of appropriate process modifications, as well as the tracking of progress and costs. Examples will be used to highlight the dimensions of the task for typical plants across a range of process industry sectors and to discuss ways in which the challenges can be overcome successfully. A top-down, structured approach will be presented that can enable an organisation to address recommendations in an efficient and timely way, while also improving the effectiveness of the studies themselves.

PERIODIC SAFETY REVIEW

ABB Global Consulting supports companies across the process industries in the management of process risk. One important aspect of process risk management is the periodic safety review of existing assets throughout their lifecycle. The objective of this paper is to share learning in relation to one specific aspect of process safety reviews; the management of recommendations arising from these programmes. The critical learning point is the benefits that can be gained by the effective planning and management of the follow-up of recommendations as a means to improve the effectiveness of risk reduction; not only in making sure that timely and effective actions are taken but – importantly – in improving the quality of the studies themselves.

The necessity and value of periodic process safety reviews of existing assets is now well-established – to combat the impact of ageing and change in the context of increasing performance expectations. These studies are being increasingly practised across the process industries. Considerable effort is being invested in what are resource-intensive and time-consuming studies and organisations need to ensure that maximum value can be gained from this effort.

The process safety review can take a number of forms, from a relatively high-level HAZID (hazard identification) or Process Hazard Review (PHR) through a HAZOP (hazard and operability study) revalidation to a repeat (or even first time) HAZOP study. A pre-requisite for the process safety review is the preparation of a comprehensive set of information, including up-to-date piping and instrumentation diagrams (P&IDs), equipment datasheets, inspection records, modification registers and incident histories. Regardless of the type of study, they are invariably difficult to arrange, time-consuming, resource-intensive and costly. They are carried out by an already-busy site-based team (often co-opted from existing roles or shift teams) with an independent facilitator. A key factor here, that leads us into the challenges of dealing with the output from a study, is that the team will invariably disperse immediately after the study, leaving a large report and many recommendations to be addressed. The question is: how can these recommendations be managed effectively?

The challenges can be summarised under three headings. Firstly, there is the risk that the recommendations from the study are not interpreted correctly. Secondly, there is the challenge of a large programme of work for an organisation that is likely to be already stretched. And thirdly, there is the challenge of the inevitable constraints on time and on cost and how these can be forecasted and then tracked – the challenge of programme management. These three challenges are considered in more detail below.

RECOMMENDATION QUALITY

The most important factor in making sure that appropriate action is taken is the quality of the recommendation. The critical requirement here is that recommendations are specific and therefore stand-alone, meaning that they can be read and understood without reference to the body of the study report. The more specific the recommendation, the less important is the gap in time between the study and the start of action. Best practice for achieving quality in recommendations is to use the *what – where – why* rule. What is to be done (expressed in a way that completion can be measured), exactly what part of the process it refers to, and the reason for the recommendation, which is normally a description of the risk exposure. An action definition and acceptance step can also be employed in which the recommendation is reviewed, the action to be taken is defined and the action is approved by an appropriate authority. Doing this quickly after the study may enable the study team to be questioned before it disperses. The action definition and acceptance process can also involve the standard categorisation of recommendations to facilitate consistency of approach in terms of follow-up. One possible means of categorisation is shown in Table 1.

It is worth mentioning at this point that, if the expectations in terms of recommendation format and categorisation are clearly defined prior to the study, then the study facilitator and team can be guided to produce high quality recommendations "right first time".

THE POTENTIAL WORKLOAD

Experience has shown that periodic process safety reviews invariably produce significant numbers of recommendations, with 20 recommendations per day being typical. This can lead to there being several hundred recommendations overall. An illustration of a typical distribution across the categories listed above is shown in Table 2.

With most organisations already fully-loaded, any periodic process safety study will present a significant challenge, especially if this challenge has not been anticipated or budgeted in terms of cost and resource. It is sometimes tempting to assume, in the case of repeat studies in an ongoing review programme, that the numbers of recommendations will diminish at each subsequent repeat study. However, experience indicates otherwise, for the following reasons:

- Successive reviews tend to go deeper into detail
- New operating and incident history will have emerged since the previous review
- New modifications will have been made since the previous review
- New lessons from external incidents will be available
- Changes to recognised good practice are published
- The expectations of stakeholders is continually increasing.

Therefore it is wise to plan for a similar number of recommendations and follow-up work to previous studies.

PLANNING AND PRIORITISATION

The second challenge is the generation of a significant programme of "new" work for an organisation that is likely to be already stretched. The default assumption may be that the owner/operator is uniquely placed to address the study recommendations, however, this is often not a practical proposition, as the volume of work precludes it being "fitted-in" around existing full time commitments.

It is true that a small subset of the study actions are best coordinated in-house (for example training and competence improvements) but there is no reason why the majority of the actions cannot be carried out by a third party, provided that they have the appropriate capability and experience, understand the recommendations and actions (including the context and goals), and know how to plan and manage the work to minimise the burden on their customer.

The next step in the process is the preparation of a prioritised plan for the management of the actions. The objective of this plan, described pictorially in Figure 1, is to define the scope of the work to be done, so that budget and timescales can be agreed and resources assigned. The prioritisation of the work will not only dictate which actions are addressed first, but should also drive efficiency of execution.

Table 1. Recommendation categorisation

Category	Example
Information finding	Confirming design criteria for pipe work
Design verification	Confirming relief valve is designed for fire case
Documentation update	Updating P&ID to reflect as-built status
Procedural improvement	Adding checks to start-up procedures
Training and competence improvement	Developing training and practices for additional emergency scenarios
Further investigation	Confirming piping can withstand temperature or pressure excursions
Design life (improved maintenance, inspection and testing)	Expanding a scheme of examination to address an anticipated deterioration mechanism
Additional physical protection (plant modification)	Adding a new safety instrumented function

Table 2. Typical recommendation distribution by category

Category	% of total recommendations
Information finding	5–10
Design verification	5–10
Documentation update	5–10
Procedural improvements	10–15
Training and competence improvement	5–10
Further investigation	30–35
Improved maintenance, inspection and testing	20–30
Additional physical protection (plant modification)	10–15

Risk is obviously the key factor in assigning priorities for action completion. The risk ranking associated with each recommendation is often assigned during the study, normally using a risk matrix to produce an overall risk score; the aim is that the score reflects the potential consequence and likelihood of the event or scenario that the recommendation seeks to address. As an example, the use of a 5 × 5 matrix could produce a range of risk scores from 1 to 25 (although events of low severity or consequence are less likely to attract recommendations and so, in practice, the range of scores would more likely range from 5 to 25). This does mean that a recommendation to provide an additional safety instrumented function could rank alongside a recommendation to update documentation, if the scenarios to which each applies are assigned similar consequences and likelihoods. This suggests that some form of moderation in terms of the degree of risk reduction to be achieved by the action is appropriate.

As Figure 1 shows, the ranking may also be moderated by considerations such as current regulatory or corporate perceptions of risk and priority associated with particular process operations or types of equipment. An upcoming shutdown or upgrade of a control or safety instrumented system may justify addressing particular actions early in the programme so that any proposed physical modifications are agreed and scoped in time for inclusion in packages of work.

Figure 1. Prioritised action plan

In planning the work a key consideration is the accessibility of the equipment itself and its associated data. Even for ageing assets, much data is available electronically these days, but the quality and consistency can be highly variable. Packaged unit data can be particularly challenging where it is not uncommon that vendor documents can conflict with owner/operator P&IDs and datasheets. An asset survey to confirm details of what is currently installed is not easy when it entails shutdown of the item or a trip off-shore to access it.

The overall plan will be determined by customer requirements for completion of particular categories of actions, coupled with availability of budget, often leading to the programme being spread over 1–2 years.

In identifying the functional resources (skills and knowledge) required to address each recommendation, a picture will begin to form of the shape of the team required, and the volume of work in each area. Each team must have at least one full time member (usually an experienced process engineer), but it is also necessary to be able to access other functional specialists, either on a part time or occasional basis.

Having this breadth of functional capability available "in-house" and local to the full time team members is one of the factors which will drive efficiency of action execution.

MAINTAINING THE FOCUS

Given the extent of the workload, it is not uncommon for study actions to be allocated to graduate engineers or students. However, experience suggests that actions will be addressed more effectively if they are handled by a multi-disciplined team of experienced people, who will have a better understanding of a mature asset. This is especially the case in the case of "further investigation" recommendations, which often arise if, as noted above, process safety documentation or knowledge is incomplete, as is often the case for older assets. The example distribution shown in Table 2 derives from such assets, with up to 50% of recommendations requiring further investigation to address whether existing safeguards reduce risk to as low as reasonably practicable (ALARP).

The focus on ALARP must be maintained by the Action Execution Team, whose *modus operandi* must be to challenge the suggested hazard scenario (consequence/ likelihood) and seek assurance that, where physical modifications are proposed, they represent an appropriate and fully-justified means to reduce risk to ALARP compared to continued operation of the asset with intervention focused on appropriate inspection, testing and maintenance. It is tempting to see study recommendations as a potential vehicle for operational improvements, but this must be firmly resisted. For every organisation there is a fixed limit to the number of physical modifications that can be processed, managed and implemented per year. Each and every proposed Change Request must therefore be justified in terms of its unique ability to reduce risk to ALARP with a clear definition of achieved benefits achieved in terms of risk reduction to offset the costs entailed. ALARP in this context should include costs of clean-up post accident.

Likewise focus must be maintained on addressing the original study recommendation. If a quick "worst case" calculation suffices to demonstrate that overpressure is not a credible scenario, then this should be the approach to swift closure of the study recommendation. Similarly, there seems little value in requesting piping engineers to spend significant time analysing the impact of a set of abnormal conditions when it is clear from the outset that the said piping systems were never designed to withstand these conditions. In this case a more critical assessment of the potential scenario, and a solution based on increased inspection/ maintenance is likely to be more appropriate rather than detailed studies followed by proposals for extensive piping modifications.

A MANAGED PROGRAMME OF WORK

Experience shows that, more often than not, actions arising from process safety study recommendations are not planned or tracked effectively to completion in terms of either progress or cost. This is the third challenge referred to above, and it is easy to understand why this proves so difficult when, typically, no overall programme of work for the study recommendations is scoped, estimated and agreed. However, if the totality of the work is addressed as outlined above, the challenge of management and forecasting completion date and final cost defaults to that of effective programme management.

Instead of undertaking a series of activities where we don't know when we'll finish and we don't know what the costs will be and how they build up against budgets, the principles of good project management can be applied to track not only quality of work, but also progress and costs.

The main consideration with respect to action tracking is the lifecycle of the process. The report from the study is not the end point! Defining how actions will be tracked in advance of the study can enable the recommendations to be produced in a format that is compatible with the tracking system, or even fed directly into the tracking system. It is also important to consider how actions will be tracked where they feed into other site systems, for example physical changes through the site's management of change system. It is important that action management links to existing site systems to ensure that the potential impact of changes introduced by the actions is risk-assessed and signed-off by the appropriate site authorities.

ABB has had very positive experiences of running dedicated Process Hazards Review and HAZOP action teams for process safety studies on existing assets. By operating dedicated and multi-functional action teams with programme management we have been able to achieve action close-out more quickly than the site organisation would be able to do. Our measurement of cost and schedule and forecasting of completion and cost have not only resulted in improved efficiency, but equipped our customers with regular reports which can be shared with both senior management and also externally, if appropriate. Assurance is thereby increased that the process is being appropriately managed and that the owner/operator is in control.

Where action management has been planned in advance of studies, we have been able to improve recommendation quality and continuity from study to action execution. Perhaps most important of all, we have been able to increase the level of assurance that recommendations are being satisfied fully in a timely way.

In conclusion, the key learning has been to take a lifecycle, programme management approach to safety reviews on existing assets to improve their quality and efficiency.