

IMPLEMENTING AND SUSTAINING HUMAN RELIABILITY PROGRAMMES OF WORK – A MANAGERS' GUIDE

Alison Hubbard and Jamie Henderson
Human Reliability

1 INTRODUCTION

Health & Safety Executive (HSE) guidance suggests that sites subject to the Control of Major Accident (COMAH) regulations should use predictive qualitative assessment techniques to identify potential human factors issues (HSE, 2007). The guidance acknowledges that 'this will be a relatively new area for many dutyholders' and explains that 'our expectation is that they conduct qualitative analyses of human performance – identifying what can go wrong and putting remedial measures in place'. Largely as a result of this regulatory interest, sites subject to these regulations are starting to undertake human reliability risk assessments.

Over the past few years, Human Reliability has had considerable experience of applying qualitative risk assessment techniques in a range of organisations. Our observation is that, once the commitment has been made to undertake this type of work, the ultimate success of the work depends, to a large degree, on how certain organisational issues are managed. Drawing on our practical experience, this paper is designed to provide some forewarning of these issues for organisations taking their first steps in this field.

To this end, an overview of one type of qualitative human reliability risk assessment is presented. Guidance is provided regarding planning, resources and timescale issues. Finally, some common pitfalls are discussed.

2 PROCESS DESCRIPTION

HSE guidance suggests that sites subject to the COMAH regulations should use predictive qualitative assessment techniques to identify and manage potential human factors issues (HSE, 2007). They provide an outline description of one such technique, describing a 7 stage process:

- Step 1: consider main site hazards;
- Step 2: identify manual activities that affect these hazards;
- Step 3: outline the key steps in these activities;
- Step 4: identify potential human failures in these steps;
- Step 5: identify factors that make these failures more likely;
- Step 6: manage the failures using hierarchy of control;
- Step 7: manage error recovery.

Over the last few years Human Reliability have had considerable experience of applying an analysis technique that is consistent with this process. Due to constraints of

space, it is not possible to provide a fully detailed description of the analysis technique; however, Human Reliability is currently developing a handbook for the process. The following sections give a brief overview of the process.

A – IDENTIFY AND PRIORITISE ACTIVITIES WITH THE POTENTIAL TO AFFECT MAJOR SITE HAZARDS

Process plants typically have hundreds of activities to undertake on site. In order to get the most benefit from the analysis process, it is important that effort is directed at the most critical site tasks. The existing site COMAH site safety report, in conjunction with a list of site procedures, can be used as an input to a task prioritisation process. This activity should be undertaken in a workshop involving individuals with a good understanding of site processes and hazards. Tasks related to hazard areas where human failures have the potential to lead to significant consequences should be identified. HSE (2007) guidance suggests that the following types of activity, in particular, should be examined:

- tasks that have the potential to initiate a major accident sequence (e.g. inappropriate valve operation causing a loss of containment);
- tasks designed to mitigate the consequences of failures (such as activation of ESD systems);
- tasks designed to prevent an incident (e.g. maintenance of safety systems).

If a large number of tasks are identified then it may be useful to further prioritise tasks using a screening process. Human Reliability use a diagnostic tool to assist with this activity. For each task, a simple scoring system is used to assess the following factors:

- Opportunities for recovery from error,
- Task complexity,
- Task familiarity,
- Requirement to defeat safety systems,
- Quality and number of hardware defences and safeguards.

All of these factors influence the vulnerability to failure. These scores are combined with an assessment of the task hazard level to provide an overall Task Criticality Score (TCS) that is used to rank order the tasks.

B – ANALYSE TASKS

The next stage of the process involves developing a clear understanding of how these critical tasks are currently performed. This is an important stage of process, since an incomplete understanding will significantly reduce the accuracy of the subsequent analysis.

Existing procedures can be used as the basis for the analysis. However, written procedures typically vary in quality, and our experience is that different individuals and shifts often carry out even the most important tasks in different ways. To ensure the analysis reflects actual working practices, individuals with a good working knowledge of

the task should participate in the analysis process. This sometimes leads to task review and a reassessment of best practice.

It is recommended that a formal analysis process, such as Hierarchical Task Analysis (HTA) be used to lend structure to the analysis (see, for example, Kirwan & Ainsworth, 1992). One of the advantages of this is that it groups tasks steps according to higher-level goals. Experienced operators often find it easier to describe *what is done* rather than the *purpose* of the task steps. Organising the task into higher-level goals helps participants to consider why they do things in a particular way. This often leads to suggestions for better task performance. HTA works well for many process industry tasks, it is particularly effective for analysing tasks such as preparation for maintenance. However, there will be some types of task, such as control room response scenarios with high decision-making content, where the approach may need to be adapted or a different analysis method used.

Task walkthroughs should also be used to ensure that the practical dimensions of the task are fully understood. In our experience, operators accept problems that have existed for a long time as part of the job. Having an independent facilitator can help operators to challenge these accepted conditions and practices.

C – IDENTIFY POTENTIAL HUMAN FAILURES

As for previous analysis stages, workshop sessions should be arranged. It is useful if the same people who attended the task analysis workshop can also attend these sessions. However, as a minimum, one individual should have an understanding of the practical aspects of the task and one should have an understanding of the potential consequences of actions.

Human Reliability use a process based on the SHERPA system (Embrey, 1986), a mature technique that has been used extensively over the past 25 years. It is similar to the process used in HAZard and OPerability Studies (HAZOP), using guidewords (e.g. action omitted, action too early) to analyse steps in the task analysis for deviations that may have serious safety consequences.

The process also identifies existing Risk Control Measures (RCMs) designed to prevent human failures from contributing to a Major Accident Hazard (MAH) event, these include, for example, alarms, automatic sequencing, deluge systems and relief valves.

D – ANALYSE FACTORS THAT MAKE THESE FAILURES MORE LIKELY

Performance Influencing Factors (PIFs) are the characteristics of people, tasks and organisations that influence human performance and therefore the likelihood of human failure. PIFs include time pressure, fatigue, design of controls/displays and the quality of procedures. Evaluating and improving PIFs is one approach for maximising human reliability. Some PIFs influence individual task steps, for example ease of access to an emergency valve. Other PIFs have a broader influence, such as quality of training or level of task experience. The potential impact of these factors for the task in question should be considered.

E – MANAGE OUTPUTS AND IMPLEMENT APPROPRIATE RISK MANAGEMENT STRATEGIES

The principal output of the risk assessment will be the specification of actions to reduce risks arising from the analysed activities. In many cases, the existing RCMs will be adequate. If this is the case, then they should be documented in the analysis output to demonstrate that the related risks are being managed. If the RCMs are not adequate, or some aspects of the process need to be altered to make the task safer, then these decisions should be made with reference to cost-effectiveness and hierarchy of control considerations.

It is vital that all proposed actions are managed using an action-tracking process. Most organisations have these systems. At a minimum, the system should prioritise the actions required, allocate responsibilities and provide a clear timeframe in which they should be completed. In all cases, the reasons for choosing a particular option, even where the decision has been to take no action, should be noted and fed back, along with the outputs, to participants in the process and the wider organisation.

In order to maximise the benefit from the analysis work the outputs can also be used to support activities other than risk assessment. For example, the structured description of the task is very useful for providing clear, action oriented, step-by-step procedures and job aids. The findings from the risk assessment can be used to annotate these procedures. For example, providing warnings and underlying reasons for actions, and can be used to produce detailed training standards for these critical tasks.

3 GUIDANCE FOR PLANNING HUMAN FACTORS RISK ASSESSMENTS

From our experience of a range of organisations, the success of the programme will depend to a large extent on how well it is supported and resourced. This section describes some of the important planning decisions that need to be made before the process begins.

PLANNING THE SCOPE AND DURATION OF THE INITIAL PROJECT

As this topic is likely to be new to the organisation, the first objectives should be to introduce the concepts to the relevant staff and to deliver results that illustrate the benefits of the process. Major accident critical tasks should be identified and prioritised at an early stage. This should give an idea of the scale of the work to be done, but it need not define it completely.

It is recommended that organisations set themselves achievable goals for the first year of application. This may be by the number of tasks to be analysed, for example, ten in the first year, or by the number of workshops organised. The site facilitator and the external consultants can then plan these sessions and identify the resources required to complete them. The sessions should be scheduled for when the largest pool of contributors is likely to be available. For example, the summer months, where many people take holidays, are best avoided. Remaining tasks can be scheduled for analysis in subsequent years. Tasks should be analysed in terms of their priority, but some flexibility can be exercised to

suit the interests of the participants. For example, if a particular task is known to cause difficulty to operators, this can be given increased priority, in order to demonstrate the benefits of the process and gain the support of the participants.

SELECTING SITE FACILITATORS

If the organisation does not have internal human factors expertise, then external consultants can supply this. However, even if specialists are engaged, they will require the close support of at least one individual on site to act as a process *facilitator*. The role of this facilitator is varied, but they must be allowed to spend a significant percentage of their time on the project, for some larger organisations this may be as much as a day a week. The types of support that they should be able to provide includes the following:

- Organising dates for workshop sessions and securing the release of task experts (e.g. field operators, control room operators, maintenance technicians) to attend these meetings.
- Supplying appropriate materials for the analysis process (e.g. procedures, P & IDs)
- Reviewing analysis outputs and presenting issues to appropriate site authorities to be addressed.
- Providing feedback to project participants, and the wider organisation, about safety improvements that have arisen from the analysis work.

Ideally, the facilitator will also take an interest in the technical aspects of the process and attend some or all of the analysis sessions. The precise role of the person is not critical; however, they should have a good understanding of the plant and have contacts across the site. It is particularly important that they are respected by, and able to communicate effectively with, both engineering and operating level staff. In the past this role has been filled successfully by process engineers, however, these individuals often have significant demands on their time.

PROVIDING THE RIGHT PARTICIPANTS

This is a bottom-up process, in that the quality of the output relies heavily on having people with the right knowledge and skills participating in the workshops. For the task analysis workshops, this means including people with extensive practical task experience (i.e. operators). This is so they can describe real working practices and task constraints arising from local working conditions, as well as any differences that exist between shifts.

The process also relies on knowledge of the potential consequences of failures in task performance. This means that at least one person with good knowledge of the plant system is required. For example, if a maintenance task were being analysed, in addition to the maintenance staff that carry out the task, an engineer with process knowledge would also be necessary.

We have found it useful to hold training sessions during project start-up, to educate potential participants and their managers about human factors issues. This training is designed to explain how the risk analysis works, but also explain the importance of human factors, usually with reference to high profile accidents.

PROVIDING RESOURCES FOR ADDRESSING IDENTIFIED ISSUES

Once an organisation has committed to a piece of work, it is usually relatively straightforward to secure an undertaking to provide resources for the analysis work itself. However, budgetary support for actions that are likely to arise from the risk assessment may be more difficult to secure. This is for a number of reasons, but perhaps primarily because the scale of these actions is unknowable until the analysis is complete.

This is important because the credibility of any process, and particularly processes that are relatively new to an organisation, depends on the participants seeing genuine benefits arising from their inputs. Therefore, it must be appreciated at the beginning of the project, by the appropriate managers, that improvement work (e.g. to plant equipment) will need to be undertaken to address deficiencies identified by the analysis. One way of supporting this is by giving the process facilitator a small working budget to undertake simpler actions. For more substantial issues, they must have access to the appropriate decision makers, and have the ability to get more significant improvements onto site action plans. All of these decisions should be taken on a cost-benefit basis. However, where the outcome is that no action will be taken, this information should be fed back to the project participants, along with an explanation of why this decision has been made.

MANAGING PROCESS OUTPUTS

Along with the specific identified actions, the analysis process typically generates other outputs that require management. These can include:

- Procedures and job aids
- Training
- Workplace improvement schemes.

The successful management of these outputs depends heavily on existing site systems. Relevant systems can include, for example, procedures management, training, competence assurance, change management and action tracking systems. We have found that it is worth spending some time at the start of the analysis process to establish the likely compatibility of process outputs with these existing site systems. This ensures that the maximum benefit from the analysis effort can be obtained. For example, if one outcome of the risk assessment is a significantly different way of doing the task, then this will need to be disseminated to operators through training and updated procedures.

PLANNING FOR ONGOING WORK

One danger with this kind of work is that it is treated as a one-off activity. The temptation, whether this is explicitly stated or not, can be to fund an initial project, over say, the duration of a year, where many of the site safety critical tasks are examined, and then assume that all human factors issues have been fully addressed. A human factors risk assessment can never be a one-off project. Sites, for example, will always be developing new ways of working, using new equipment and changing levels of manning.

Ideally, sites should have their own expertise to manage human factors issues in an integrated manner. It is worth, therefore, considering at the start of this type of project how the site envisages managing these issues in the future. If the expected outcome is that it will be managed internally, then consideration must be given to training the staff who will be implementing the recommendations in order to effectively transfer the skills and knowledge. Moreover, time must be allocated to the individual(s) charged with undertaking these responsibilities to enable them to complete the work. Too often, the responsibility is added to a long list of other duties, with no recognition of the additional time it will take.

Some sites find it simplest to outsource the work to external consultants, thus enabling their key staff to remain focussed on their day-to-day site duties. In this case, it is important to maintain points of contact between the external consultants and site staff. Here, the role of facilitator (see previous discussion) is pivotal.

WIDENING THE SCOPE

This task-based approach to human reliability risk assessments has been implemented successfully in large and small COMAH sites. One of the reasons for its success is that it quickly draws attention to task specific, MAH safety issues (e.g. task design, valve labelling, access, unreliable instrumentation, poor interface design, alarm issues). These issues are easy to communicate, clearly linked to risk management and specific enough to address.

For a site new to the topic of human factors, this clear link between human factors issues, MAH and solutions can be the easiest introduction to human reliability and human factors. Other approaches, for example human factors audits of site systems (e.g. shift handover, procedures, training, change management), whilst important, can result in general recommendations that can be hard for a site to address. In addition, when first introduced to human factors, some people find it difficult to make the link between these general issues and process safety. Starting with a task-based risk assessment helps a site identify specific issues as well as providing an insight into strengths and weaknesses of more general site systems. Having established weaker areas in such systems, these can then be subjected to more detailed human factors reviews. Having Human Factors expertise within the organisation or from an outside source can help to capitalise on issues that are raised during the qualitative risk assessment process.

4 POTENTIAL PITFALLS

Every organisation is different in terms of their culture and the way work is managed. In our experience, different organisations face different obstacles when carrying out human reliability programmes. Some issues have been alluded to in the previous sections, for example, involving the right people in the analysis. This section includes an overview of some problems and issues that have arisen in previous projects.

KEEPING THE FOCUS ON MAJOR ACCIDENT HAZARDS

The primary focus of these types of analyses is major accident hazards. However, as tasks are scrutinised, other issues related to occupational process safety and process efficiency are uncovered. These are also important issues, and are useful to pursue if time is available. However, where time is limited this can result in the lengthy and complex analyses. Therefore, facilitators must be careful to keep the focus on major accident hazard issues during workshops.

MAXIMISING PROCESS EFFICIENCY

Qualitative Risk Assessment needs to be a systematic, rigorous and thorough. However, as with any similar process, there is a danger of the analysis itself becoming the goal, rather than improved process safety performance. Therefore, the analysis team needs to remain vigilant to ensure that the balance between effort put into the assessment and the resultant benefits is appropriate.

In order to achieve this we suggest the following strategies:

Transfer of lessons learnt between tasks

Tasks of similar types can be grouped together during the initial prioritisation stage. For example, the top four critical tasks identified by the screening process may all involve process isolations. Rather than repeat the complete analysis for four similar tasks, the most critical process isolation could be used to identify general issues regarding the management of isolations, as well as specific issues related to that particular isolation. It is likely that the general issues will be common to all isolation operations, saving time when analysing further tasks of this type.

Keep the level of detail proportionate to risk

Human Reliability advocate the use of structured task analysis, since we have found that reliance on walkthroughs and written procedures can lead to significant issues being missed. One of the strengths of HTA is that it allows the level of detail in one part of the analysis, where the hazard is greater, to be higher than in less hazardous parts of the task. With experience, the analyst can use this feature of the analysis technique to reduce the effort required.

Responding to identified issues

There can be a danger, when responding to issues identified by the analysis, to rely on training and procedures as solutions. These are an important part of a site's risk management systems. However, a proper review of hierarchy of control and cost-benefit principles must be undertaken for all identified issues before deciding on appropriate responses. This can be assisted by a employing a multidisciplinary team (e.g. operators, maintenance engineers, managers, human factors specialists) working together to identify the best response.

An additional point is to beware of the sticking plaster approach. As described previously, the nature of the process means that task specific issues are readily identified. The facilitator should consider whether the issues raised are indicative of wider problems (e.g. a

problem with a stiff and difficult to operate valve may indicate problems with the valve maintenance regime). In particular, management factors such as allocation of resources, determining priorities, managing change should be considered as important potential issues.

OBTAINING A CONSENSUS BETWEEN PARTICIPANTS

Our experience is that even the most critical tasks are regularly performed in different ways by different shifts and individuals. Often these deviations are insignificant, but occasionally they have short or long term consequences for process safety. There is not space here to discuss fully the reasons for these deviations; however, the way that organisations manage these variations in critical task performance has a significant impact on process safety. We believe that it is important to use representatives from different shifts when conducting human factors risk assessments. Operators should feel able to explain why they might need to deviate from standard practice: if nothing else, this leads to suggestions of ways that tasks might be improved. Usually there are good reasons for these variations, and providing a forum for operators to discuss these issues will help in their resolution. However, once the analysis has been completed it is important that the outputs be transmitted to training and competence departments, to ensure that all operators understand why tasks should be done in a particular way.

LACK OF BUY-IN TO THE PROCESS

Management support, beyond the initial commissioning phase, is critical to the success of these types of analyses. This can be a particular problem on smaller sites, where there are fewer specialists, and people have many tasks competing for their attention. The success of the analyses depends on the inputs from site staff. If they are taken away, or remove themselves, from workshop sessions to undertake other duties, then it is difficult to get an adequate quality of output. Moreover, the status of the process suffers in comparison with other site activities. Proper planning can reduce the prospect of this happening. Participants should have sufficient work time allocated to the project. Moreover, it is important that managers keep the profile of the project at an appropriate level, and assign it comparable priority with other on-site activities and ongoing projects.

A related issue is the speed with which recommendations can be implemented. Proposed changes have to compete for site resources with outputs from other projects and, for less critical alterations, it may be several months, or even years, before a change will occur. During these periods, it is important to maintain feedback to participants regarding the priority and status of these actions. In the absence of feedback, and without immediately apparent outcomes from their inputs, then there is the danger that participants will become disillusioned with the process.

FAILING TO SUPPORT PARTICIPANTS

Often, the individuals involved in the analysis process are also the same people that will be called upon to effect the changes arising from the analysis. If participants lack the resources

to address all the issues they raise, this can at best lead to disillusionment with the process, and, at worst, result in information regarding issues being withheld. Therefore, as previously discussed, process facilitators must be supplied with the time and resources to be able to capitalise on the insights gained from the analysis process.

5 CONCLUSION

In summary, the HSE provide a useful, straightforward guide to carrying out human reliability risk assessments. This paper provides additional useful insight into successful implementation of this seven-step process. Human Reliability have implemented these types of assessments at a number of organisations within the process industries, and have observed that the success of these types of project depends, to a large extent, on the way they are planned and resourced. This paper has identified some issues that, when addressed at the planning stage, substantially influence the benefits that arise from implementing human reliability assessments and increase the likelihood of them being successfully integrated with other site safety management systems. We have also identified some common pitfalls with these types of techniques that can be avoided throughout the programme.

REFERENCES

Embrey, D.E. (1986) SHERPA: A systematic human error reduction and prediction approach. *Paper presented at the International Topical Meeting on Advances in Human Factors in Nuclear Power Systems*, Knoxville, Tennessee.

Health & Safety Executive *Core Topic 3: Identifying Human Failures* http://www.hse.gov.uk/humanfactors/comah/core3.pdf

Kirwan, B., & Ainsworth, L. K. (1992) *A Guide to Task Analysis*. London: Taylor & Francis.