Competence assessment for the hazardous industries

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Competence assessment for the hazardous industries

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COMAH duty holders recognise the importance of experienced and competent staff. With the implementation of the Control of Major Accident Hazard Regulations 1999 (COMAH) on April 1st 1999, it is no longer acceptable to make untested assumptions about staff competence. The Health and Safety Executive have developed safety report assessment guidance that asks for a competence assurance system that includes the setting of appropriate competence standards, assessment and reassessment of competence. The HSE also ask that there be a specific link between identified safety critical tasks and a targeted comprehensive management system. This report provides (1) a review of current practice, (2) a view of what comprises good practice in the field of competence assessment in relation to major accident prevention, and (3) a body of advice, checklists and examples of assessment. The report has drawn together experience, standards and lessons learnt from a number of high hazard industries, particularly chemicals, offshore, nuclear and aviation. It has also given due regard to the guidance on competence assessment laid out by personnel specialists, national certification bodies and institutes.

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EXECUTIVE SUMMARY

Background - why competence assessment?

Why is competence assessment considered important? Firstly, review of past major incidents (such as the Longford explosion summarised below) indicates that the lack of certain skills or knowledge has led to errors that contributed to the incident. In each case, it had been assumed that an individual with a certain level of experience or training would be competent and/ or that the dissemination of a procedure would be sufficient. In addition, the concern about competence is further increased by the move towards multi-skilling, delayering and downsizing. Staff are increasingly expected to take on a wider range of responsibilities with less supervision. This increases the need to check competence.

The Longford explosion

The most recent example entails the Esso Gas Plant explosion in Longford, Australia, wherein the loss of oil circulation resulted in the plant getting colder followed by the rupture of a heat exchanger on restart due to cold metal embrittlement. The inquiry concluded that there was ample evidence that operators did not appreciate the dangers of cold metal embrittlement despite being trained about it. The inquiry reports that operators were tested during training modules and that in the event of incorrect answers further coaching was provided. However, after coaching the "re-assessment" comprised asking the operator if they now understood the matter. If the operator indicated they understood the matter it was ticked off. According to operators it took courage to say you did not understand the re-explanation.

The Commission found, during questioning, that operators still did not see what was wrong with their answers. In addition, the inquiry found that operators gave answers without actually understanding them. In particular, operators knew the correct answer to a question on the action of a valve was to prevent "thermal damage" but did not know what was meant by thermal damage. They gave the answer thermal damage because that was the answer in the training manual. The assessment tested whether operators could present information received from training back to the assessor, without testing understanding.

With the implementation of the Control of Major Accident Hazard Regulations 1999 (COMAH) on April 1st 1999, it is not acceptable to make untested assumptions about staff competence. The Health and Safety Executive (HSE) as part of the COMAH enforcing Competent Authority (others being the Environment Agency and Scottish Environmental Protection Agency) has published guidance that requires "For hazardous events that could lead to a major accident, the safety report should show that risk-reduction measures have been put in place to reduce the risks to as low a level as is reasonably practicable." This general guidance is made specific to the matter of human performance. HSE Safety Report Assessment (2001) guidelines require that "The safety report should show what measures are in place to ensure adequate performance by human operators, .." Indeed, the HSE asks, in their Human Factors Working Notes for COMAH Safety Report Assessment (HSE 2001), for a competence assurance system that includes the setting of appropriate competence standards, assessment and reassessment. The note also asks that there be a specific link between identified safety critical tasks, roles and responsibilities and a targeted comprehensive management system.

Competence assessment is intended to improve accident prevention in the following ways:

- Identify and fill gaps in individual's competencies before they contribute to a major incident;
- The development of standards will provide individuals with a clear view of what competencies they need, and hence should encourage development of competencies;
- The requirement for Duty Holders to set performance standards should prompt them to provide appropriate training and, if incidentally, reveal where unrealistic performance expectations exist for staff;
- Competence assessment may reveal that sub-standard competence is occurring;
- The inclusion of competence assessment within a planned management system should reduce the likelihood of substandard staff performance being overlooked, and indeed help lead to continuous improvement, and;
- The setting of standards and associated assessment of competence should mitigate the pressures arising from organisational change for staff to work beyond their limits.

In addition, a demonstrable process of competence assessment should provide assurance to regulators and other stakeholders that a core aspect of safety case, namely staff competence, is valid. This can be particularly important in the case of older plant, which can fail to meet latter-day operability standards and may lack up to date procedures, whose safety is based on the ability of staff to compensate for lower operability standards. It is also an important part of demonstrating the balance between reliance on procedures versus staff competence, i.e. to what extent do tasks need to be proceduralised rather than relying on staff competence?

What is competence assessment?

The question is often asked "What is meant by competence?" Competence is commonly regarded to be the ability to perform the activities within an occupation or function to the standards expected in employment. This definition makes reference to standards. Thus, competence is equated to an ability to perform to the expected standard. Hence, competence assessment entails measuring a person's performance against a standard.

In the context of COMAH competence is the continuing ability of individuals and teams to perform reliably the Major Accident Hazard elements of their roles, responsibilities and tasks, and for this to be demonstrable. Following on from this is the implied need to have a set of competence standards that directly cover the Major Accident Hazard elements of jobs and suitable forms of assessment.

It is also important to note that the definition of competence is outcome-based. It leads to the view that competence assessment entails the collection of sufficient evidence of workplace and / or personal performance to demonstrate that the individual can perform to the specified standard. This definition of competence is important in two respects. Firstly, it highlights the need to recognise the difference between recording a persons experience / training and assessing their competence.

Secondly, this outcome-based view of competence assessment can be compared with the common objectives of selection and recruitment. That is, selection and recruitment processes often aim to predict whether a person has the appropriate underlying characteristics and knowledge for a job. Accordingly they test personality, aspirations, underpinning knowledge and attitudes with the expectation that they will be able to perform competently with the passage of time and appropriate experience and training. Standard selection processes do not necessarily require an individual to be fully competent at the time of appointment. This also highlights the difference between aptitudes and ability, wherein a person can have an aptitude but may lack the ability to apply it to good effect.

These distinctions are important in the context of COMAH, as it is insufficient to assume that a standard selection process (which often focus on aptitude rather than ability) ensures competence. In addition, in the context of COMAH it is necessary to demonstrate specific aspects of knowledge, such as awareness of operating safety limits, how a process upset may lead to a major incident, what are the major hazards on a site and how may they occur.

Competence assessment as part of competence assurance

Competence assessment should form just one part of a wider competence assurance process, where competence assurance covers the process of training, development of procedures, supervision and other forms of employee assistance. Indeed, the HSE have issued guidance on competence management for the Railways sector (HSE, 2002). This guidance places competence assessment in the context of a competence management system.

Current practice

Review of current practices within and outside the onshore hazardous industries indicates that there is wide variation in the standard of competence assessment. In some cases Duty Holders have developed systematic approaches to competence assessment and even made explicit links between the COMAH safety report risk assessment and competence assessment. In other cases reliance is placed on unstructured on-the-job review.

The most frequent method of competence assessment is that of 'observational assessment' by a supervisor or appointed trainer. In some cases the assessment of operators and maintenance staff rely on unstructured peer review, a practice considered as poor by this study. However, in some companies this judgement is guided by the use of validated task descriptions, skill and knowledge inventories, verbal test questions, and guidelines on (for example) the number of times a person needs to correctly perform a task to be deemed competent.

Three of the surveyed onshore companies have used some form of task analysis in order to identify safety critical task and define the correct way of working for use in assessing their staff. Some companies carry out a form of risk assessment to identify safety critical tasks for which they require assurance of staff competence. Assessors can then test a person's knowledge by asking them how they would carry out a particular task and probe their understanding of (say) the safety function of equipment and key safety procedures. However, two other surveyed onshore companies had no systematic approach for defining tasks.

Also, in the case of safety critical emergency roles, such as control room management of process upsets, there are examples of the application of "advanced" forms of assessment, such

as the systematic use of simulator based assessment of decision making and command skills. Finally, in some cases assessor competence has been addressed by the use of trained assessors.

Lessons from other high hazard sectors

The review of practices in other sectors highlights a number of key points. First, there are examples of competence assessment being managed as part of a cohesive, planned and managed process. In particular, the nuclear sector has developed a process of ensuring Suitably Qualified and Experienced Personnel perform all tasks. A competence – job matrix is used to determine competence requirements for each job against which staff are assessed.

Another example can be found in the aviation sector wherein there is a set of training, experience and assessment requirements for pilot qualification covering initial appointment, progression from one grade to another, transfer between aircraft types and ongoing competence assurance. The range of tasks, experience and knowledge required is laid out in standards.

Finally, the assessment of offshore installation managers, air pilots and submarine commanders provide examples of how to assess the competence of emergency response roles. In particular, these examples entail the use of simulators and exercises based on accident scenarios taken from risk assessments, and the use of behavioural checklists by observers to guide the assessment of performance on "softer" competencies such as delegation, communication, decision making under stress, information acquisition etc.

Comparison of "standard" assessment and safety related competence assessment

In many ways the approach to the assessment of competence in safety critical roles does and should mirror the approach advocated for competence assessment in general. In particular, the concept of collecting evidence of performance, the need to set performance criteria, independent, credible and competent assessors and the use of standards outlining key skills and knowledge are all equally pertinent. However, it is apparent that there are some particular requirements and practices in the context of major accident prevention. These include:

- A need to ensure that the process of competence assessment is managed in a systematic and proactive manner to a standard commensurate with major accident prevention;

- High-risk industries tend to place more emphasis on certain methods due to the relative importance of certain types of tasks and the need to provide a particularly high level of competence assurance for safety critical roles. In particular, high-risk industries tend to place more emphasis on:

    - The role of risk assessment in identifying competence needs.
    - The use of task analysis to identify the skills and knowledge entailed in complex technical tasks;
    - The development of techniques, such as the use of behavioural markers to assess "softer" skills such as communication in emergencies;
    - Licensing (in the nuclear and aviation sectors) – again reflecting the need for a high level of assurance and very high standards of competence in certain safety critical tasks;

- The role of simulators and exercises, due in part to the rareness of emergencies but again reflecting the importance of assessing competence for handling emergencies, process upsets and rare events such as shutdown and start up.
- The need to monitor and maintain competence, in particular recognising the need for skills to be maintained to handle infrequent events and to ensure staff maintain technical skills and knowledge to operate processes and equipment.

Thus, whilst there are many commonalities between "standard" competence assessment and assessment for safety critical tasks, the characteristics of high hazard tasks and the need for a high standard of assessment does mean that specific attention must be awarded to the design of competence assessment for major accident prevention.

Competence assessment advice

In order to develop a process of competence assessment, it is necessary to answer the following points:

- What competencies need to be assessed to ensure that error or sub-standard performance will not contribute to a major accident?
- Are the competence expectations realistic?
- What assessment criteria and competence standards, including what level of performance evidence, are required to ensure risks are As Low As Reasonably Practical?
- What method(s) of assessment are required to acquire evidence of competence?
- What qualifications and experience do assessors need to be credible and competent?
- How often should performance be reassessed, reflecting the level of risk and possibility of skill decay?
- What method(s) of reassessment are needed?

This entire process should be managed proactively as per any aspect of accident prevention.

Identifying safety critical tasks/ jobs

It is envisaged that competence assessment commences with the identification of safety related tasks or jobs using techniques such as risk assessment and task / job analysis. Such an assessment should cover all forms of activity, including normal process operation, process upsets, planned and unplanned maintenance. At this stage the analysis may simply provide a task or activity inventory for which assessment is required in the context of major accident prevention.

Define performance standards

Next, a set of performance standards and assessment criteria are defined. This entails analysing the types of competencies required, describing what comprises adequate performance and defining measurable criteria by which to judge performance. At this stage a more detailed task analysis and / or specification of competences may be required to help develop testable competence standards. The task or competence description should provide a view of:

- The correct way of doing a task (against which a person's performance can be judged), and;

- Key competences (Skills, behaviours and underpinning knowledge).

The task need only be decomposed to a level that enables the production of testable task / competence descriptions.

As befits the task, competence standards tend to cover:

- Skills, such as being able demonstrate an ability to (say) interpret process instrumentation readings, diagnose faults, operate controls, enact a procedure;
- Underpinning knowledge, such as understanding the chemistry of a reaction;
- Safety behaviours and attitudes, such as safety leadership, communication, teamwork.

It is reiterated here that assessment should aim to acquire performance-based evidence that a person can carry out a task, rather than just collate evidence of underpinning knowledge. Thus, standards should denote demonstrable skills and testable definitions of what comprises "competent" performance. Examples of competence assessment criteria are given below.

- Operators involved in emergency response need to successfully carry out an emergency response procedure on three separate accident scenarios selected from the safety case;
- Supervisors must correctly manage an operation, such as removing a hydrocarbon pump, starting from developing the plan of work, specifying a permit to work, instructing staff, monitoring their work, checking pump integrity prior to start up… etc;
- Safety engineers must be able to correctly interpret a piping and instrumentation diagram, identify all (contrived) engineering defects and specify safety devices and engineering modifications as noted in company standards;
- A maintenance technician should be able to recollect all key safety actions required in the isolation of a hydrocarbon pump, its dismantling and restoration.

These may be augmented by "tests" of underpinning knowledge, such as:

- Minimum periods of "observed" experience – taken to be indicative of competent performance;
- Qualifications and training - used as an indication of the level of underpinning knowledge;
- Verbal or written examination of a person's knowledge and/or attitudes.

Thus, a range of criteria may be devised, each matched to the type of competence (observable skills and behaviours versus underpinning knowledge).

The competence standard may assume or require a certain level of supervision, and hence there may be a scale of competence standards for people of varying competence. This is illustrated by the Institute of Electrical Engineers competency guidelines for use with safety practitioners working on safety related Electrical, Electronic and Programmable Electronic Systems. The standards of competence are graduated for supervised practitioners, practitioners and experts.

It is common practice to use national qualifications as a means of demonstrating skills and knowledge. Whilst this is entirely reasonable it is important to:

- Ensure that the national qualifications cover the specific skills and knowledge required by the site's processes, equipment and activities, including site specific safety matters;
- Recognise that NVQs by their nature are limited to assessment of on the job performance and hence may not cover infrequent safety critical activities, such as emergency response, process upsets, infrequent maintenance activities etc;
- Ensure that the form of assessment and level of performance evidence collated matches the safety criticality of the processes, equipment and activities.

It is pertinent to note that in some case studies the implementation of NVQs is guided by in-house assessment of the specific skills and knowledge associated with the site's processes, equipment and activities. In addition, it should be noted that some organisations have felt that their assessment process has been "NVQ driven" rather than driven by their range of activities. Finally, as NVQs are designed to cover all aspects of task performance, they may include tasks and activities that have relatively little bearing on major accident prevention. Hence, whilst NVQs may assist with the demonstration of safety related competences, major accident prevention may not by itself require completion of the entire NVQ syllabus.

Select assessment method

Once the task and type of competences are understood, an appropriate assessment method can be identified. The method of assessment should provide a valid and reliable measure of the type of competence in question, such that two different assessors would give similar results. Ideally the reliability of the assessment process would be monitored by review of actual performance, i.e. does the standard of staff performance accord with the results of competence assessment. If sub-standard performance is observed, in contrast to acceptable assessment results, the validity and reliability of the assessment process should be reviewed. In summary;

- Physical / sensory-motor competences can be demonstrated by practical "show me" assessments wherein people either complete the real task or a component of it, such as driving a road tanker to demonstrate steering skills.
- The ability to carry out a prescribed procedure of work can, usually, be demonstrated by a "show me" test wherein you attempt to complete the task.
- Cognitive skills, such as the ability to (say) assimilate process control information from a VDU and thereafter interpret it might be demonstrated by the candidate talking through the interpretation of displayed information. However, such verbalisation may interfere with some cognitive skills whilst it may not be possible to verbalise other cognitive skills, such as mental arithmetic. In these cases post task debriefing of candidates may be appropriate.
- Whilst satisfactory completion of a task that requires the use of knowledge, such as fault diagnosis, may be indicative of underpinning knowledge, it is possible that the correct action was by luck. Accordingly, knowledge tends to be assessed through verbal or written questioning.
- Whilst psychometric personality tests may provide a prediction of interpersonal, team management and safety behaviours, observation of actual behaviour in the real or simulated work setting using behavioural observation tends to provide a more valid measure.

Assessor competence

Assessors should be competent in the process of competence assessment and have adequate knowledge and experience of the tasks being assessed. The level of expertise in assessment should be matched to the form of assessment and the need for the assessor to be credible in the eyes of the candidate. For example, in-house coaching on how to complete assessments may be adequate for "on the job observation" of simple operation tasks, but completion of NVQ units D32/33 may be needed for (say) assessment of more complex operational tasks. In the case of behavioural competences such as team coordination and communication assessors may need to be trained on what comprises "good performance", what are the behavioural markers and how to gauge performance against these markers.

Ongoing assessment

Finally, ongoing "competence checking" needs are determined by consideration of how competencies may decay over time and the safety criticality of the task. More frequent assessment tends to be required for higher risk tasks and tasks wherein skills may decay sooner. All persons tend to be assessed at least annually in the form of a performance appraisal based on line management observations. People involved in complex safety critical tasks, such as process managers or control room operators, may be appraised more formally every 1 to 3 years. The highest risk tasks may be assessed every six months.

There are a number of considerations regarding the form of reassessment to apply. In the case of infrequent tasks, such as emergency response or response to a process upset, normal day to day work may not provide any opportunities for performance to be demonstrated. In such a case, it may be necessary to set tasks, run simulations or exercises. On the other hand, day-to-day work may provide a valid indication of performance in the case of routine frequent task, such as road tanker driving. However, there is an additional array of sources of evidence of performance available once a person is in post. These can include:

- Standard SHE audits can cover the performance of safety critical tasks, specifically the level of adherence to safe practices and individual performance;
- The contribution of individual competence to an incident can be assessed as part of the incident analysis process;
- Many companies use behavioural observation schemes that can provide observations of safety related behaviour that can be used as the basis of one to one coaching.
- Peer review: On the job performance can be monitored and appraised by line managers, but this does need to be formalised and systematic.

The latter sources of evidence may compliment more formal forms of assessment.

Responding to sub-standard performance

It is clearly important to have a pre-planned response to the identification of sub-standard performance to enable the company to act purposefully on the results of competence assessment. The response to sub-standard performance tends to vary according to the purpose of the assessment and the safety criticality of the task.

In the case of selection, promotion and recruitment decisions the discovery of sub-standard performance tends not to pose a significant "policy" problem, in that people are simply not appointed to the position and /or are required to undergo further training / experience. Once a person is in post, the discovery of sub-standard performance tends to pose a more difficult challenge. First, it is important to check whether the sub-standard performance arises from omissions in training, supervision or other factors such as inadequate procedures or equipment. If the sub-standard performance is attributed to the individual, there are at least three common responses, namely retraining staff, increasing the level of supervision and placing limits on the scope of an individual's role and responsibilities. In the case of the most safety critical roles, it is likely that a person will be required to demonstrate competence, perhaps by undergoing re-assessment, before they are re-authorised to take on their normal duties again, especially if they normally work unsupervised or are a key decision-maker such as a process supervisor.

Advice on implementation

The following advice on the practical implementation of the ideas in this report was solicited from COMAH Duty Holders during three seminars at which this report was presented.

Given that there are potentially a large number of safety critical jobs and tasks on a COMAH site it is advised that:

- The development of competence assessment arrangements is prioritised by ranking jobs/activities in terms of their safety criticality, and;
- A gap analysis is completed to establish which jobs/tasks are least well assessed, with further work focused on the highest risk jobs/tasks that are least well assessed.

The results of risk assessments completed for other purposes and the listing of major accident scenarios within Safety Reports could be used to guide this prioritisation.

As regards the development of standards and assessment methods it was suggested that Duty Holders could first explore whether:

- More use could be made of existing national vocational standards?
- Current operating procedures could be used in assessing individual competence?
- Assessment could be integrated into COMAH emergency exercises?

As regards the management of competence assessment, advice includes:

- Developing a matrix of jobs and key competencies;
- Create a (computerised or paper) log of assessment of individuals;
- Integrate the audit of competence assessment into the wider safety management audit process.

Conclusion

Organisations operating high-hazard plant recognise that major accident prevention is predicated upon the experience, commitment and competence of their staff, including their contractors. The COMAH regulations and the lessons learnt from major incidents indicate that it is not enough to assume that exposure to training and experience assures competence. There are already examples of good practice in the development and application of competence standards and systematic assessment methods. This study provides a summary of these practices in a sufficiently general way that the diverse range of sites regulated under COMAH can apply.

The main report provides a set of advice, checklists and examples for use by Duty Holders.

Industry feedback on the report

The advice in this report has been scrutinised in detail by six COMAH duty holders and presented for review at three seminars of about 150 individuals in total from COMAH duty holders, representing refineries, chemicals, explosives, gas, power generation, storage and other operations. The advice and checklists in this report take account of their feedback. Additional advice has been provided on implementation, whether tasks or jobs should be the starting point of standards setting, terminology was clarified, the definition of competency was elaborated and advice on where competence assessment fits into wider competence assurance has been provided.

Duty Holders thought that the ideas in the report provide a systematic and demonstrable way of assessing competence, and that implementation of the advice would be an improvement on most Duty Holders current practices. It was stated that "The Assessment guidance is very good".

Many delegates could identify some examples of good practice in their firms although only a few delegates indicated that their firms consistently followed the advice as a whole. It was also indicated that the advice is consistent with "standard" competence assessment arrangements and hence should be compatible with current industry practice. As stated by one delegate, they were reassured that in some cases "Naturally occurring evidence is acceptable evidence" of competence.

The strengths identified by Duty Holders included:

- The advice can be used generically across industry;
- The advice contains good definitions;
- The approach encourages the analysis of tasks;
- The approach could be audited and is very demonstrable :
- The approach is more systematic than what firms do at the moment;
- The approach ties up with NVQs;
- Very useful, black and white and straightforward

The main areas of debate comprised the level of resources required to fully implement competence assessment and how to assure the competence of contractors. As regards the resource requirements, it was noted that a programme of competence assessment could be implemented over a number of years, with higher risk jobs prioritised. It was recognised by delegates that the competence of contractors (completing safety critical work) is of equal importance as staff competence. However, researchers and delegates agreed that further thought needs to be given to how best to implement competence assessment amongst contractors.

1 INTRODUCTION

1.1 COMAH AND COMPETENCE ASSESSMENT

1.1.1 Lessons learnt from past accidents

The safe operation of major hazard installations is dependent on the competence of the people operating, maintaining and managing them. Many duty holders assert as part of their safety case that they have experienced and competent staff. It is often stated that staff do not need to be constantly supervised or be required to constantly refer to written procedures, due to their competence. The validity of these assertions is not usually contested.

So it may be asked why is competence assessment considered important? Firstly, review of past major incidents indicates that staff have, on occasion, unknown to the company lacked key safety knowledge and skills. For example;

- The supervisors with responsibility for inspecting and maintaining the automatic train warning system, of the train involved in the 1997 Southall rail crash, did not correctly understand the test procedures;

- Events during the 1988 Piper Alpha disaster demonstrated that offshore installation managers did not competently manage major emergencies;

- Persons responsible for developing safe systems of work have been shown, by the occurrence of major incidents such as the Hickson and Welch fire and explosion of 1992, to lack a full understanding of how processes work and how hazards may materialise.

In each case, it was assumed that a person with a certain level of experience or training would be competent and/ or that the simple dissemination of a procedure would be sufficient. The individual's actual competence was not sufficiently tested.

The most recent example entails the 1998 Esso Gas Plant explosion in Longford, Australia, wherein the loss of oil circulation resulted in the plant getting colder followed by the rupture of a heat exchanger on restart due to cold metal embrittlement (Hopkins, 2001). This example highlights that competence assessment is not necessarily a simple matter. The inquiry concluded that there was ample evidence that operators did not appreciate the dangers of cold metal embrittlement despite being trained and being tested. It appears that the assessment did not test for real understanding because operators could give the correct answer to questions without understanding what they meant.

The concern about competence is further increased by the move towards multi-skilling, delayering and downsizing. Staff are increasingly expected to take on a wider range of responsibilities with less supervision. This increases the perceived need to check staff competence.

1.1.2 COMAH requirements

With the implementation of the Control of Major Accident Hazard Regulations 1999 (COMAH) on April 1st 1999, it is no longer acceptable to make untested assumptions about staff competence. The purposes of the COMAH regulations are to prevent major accidents involving dangerous substances, and limit the consequences to people and the environment of any that do occur. The regulations outline the requirement to ensure that all risks are adequately and appropriately controlled in terms of the design and management of a site, including the implementation of safety critical control systems. Even in the most automated site there will be considerable human involvement in the process, whether it is the design, maintenance or operation. As such the human has a key role in the causation, prevention and in the mitigation of an incident and their competence is central to ensuring the effectiveness of the controls. The regulations require that the major accident prevention policy statement (MAPPS) include arrangements for the recruitment of competent personnel, as well as arrangements for meeting the training needs of competent personnel, as noted below in the extract from the HSE published Safety Report Assessment Manual.

"Criterion 4.11 ***The safety report should show that the operator has in place a system for providing and maintaining appropriate levels of management and employee competence.***

A system is essential for ensuring that adequate levels of competence of all personnel who have an impact on safety are provided and maintained. Managers and employees need to have the necessary knowledge, skills and experience to be able to meet their responsibilities for the control of major accident hazards. The safety report should show that people having key roles in the control of major accident hazards are competent in relation to their responsibilities.

Guidelines published by the Health and Safety Executive concerning issues that should be considered within the safety report and MAPPS on the competence of staff include:

- Training needs analysis; ensure that the training process includes all appropriate elements to carry out the role;
- Safety critical procedures; ensure that the post and all safety critical elements have clear procedures outlining the required activities, and their use is part of training.
- Competent and credible trainers; adopting the most appropriate means of training, which the training process is executed by trained and competent trainers, and that the methods adopted for carrying out training are suitable for the task. Assessors need to have pertinent experience and knowledge of the subject matter to be credible.
- Competence assessment; ensuring that individuals are capable of carrying out the task safely and properly through carrying out an assessment of their skills and knowledge.
- Refresher training for critical and infrequent tasks; certain activities will be infrequently performed, for example emergency procedures, and as such it is important that individuals skills are adequate when

required. This places particular challenges in terms of skill decay, knowledge and the levels of refresher training required.

- Selection process; e.g. ensuring that individuals are recruited that are capable of acquiring the appropriate competencies to carry out the role, i.e. are individuals with appropriate skills, qualifications and experience recruited.

(ref. Human Factors for COMAH safety report assessors, HSE, 2001)

These requirements are matched by similar requirements in other high hazard industries. In the railway sector the HSE has issued Safety Principles and Guidance on Competence Management and Assurance (HSE, 2002). Nuclear installations operate a system of Suitably Qualified and Experienced Personnel (SQEP). Airline pilots are required to go through a thorough testing and examination process to be licensed. More recently the Institute of Electrical Engineers and British Computer Society have developed Competency Guidelines for Safety-Related System Practitioners for use in the medical, chemicals, aerospace, defence, transport, power generation and manufacturing sectors.

The requirement to ensure staff are competent is not new. For example, the Control of Substances Hazardous to Health Regulations (1998) requires that employees be competent in the use and handling of equipment/substances. Similarly, the guidance for the Provision and Use of Work Equipment Regulations (1998) asserts that the employer should identify the level of employee competence to operate work equipment. However, the COMAH regulations introduce some new dimensions. First, each Duty Holder is required to submit a safety report that demonstrates how they assure safety. Secondly, the COMAH regulations focus on the prevention of major accidents and hence highlight arrangements for the safe operation, maintenance and management of process plant.

1.1.3 The role of competence assessment

Accordingly, the new requirements under the COMAH regulations and the evidence that it is unsafe to assume staff are competent simply by virtue of their exposure to training and experience, come together to introduce an increased need for Duty Holders to proactively and systematically assess the competence of staff. Competence assessment is intended to improve accident prevention in the following ways:

- The assessment of individuals should identify gaps and weaknesses in individual's competencies (before they contribute to an incident) such that these gaps are resolved by further training, coaching or experience;

- Assessment should help validate training and experience;

- The development of standards laying out necessary skills and knowledge will provide individuals with a clear view of what competencies they need to operate safely, and hence should encourage them to develop such competencies;

- The requirement for Duty Holders to set performance standards should prompt them to identify necessary skills and knowledge and hence provide appropriate training;

- The setting of competence standards should also, if incidentally, reveal where unrealistic performance expectations exist for staff, such as expectations to respond to alarms on a remote control panel within a minute despite it taking (say) 5 minutes to reach the panel;

- Competence assessment may reveal that sub-standard competence is occurring due to inadequacies in training and qualification requirements, thereby prompting improvements in training systems – without competence assessment it is difficult to know if the training is having its intended effect;

- The management of competence assessment within a planned and proactive management system should reduce the likelihood of substandard staff performance / competence being inadvertently overlooked, and;

- The setting of standards and associated requirement to assess competence should help to mitigate the pressures arising from organisational change that can lead to pressure on staff to work beyond their limits. For example, it can provide a baseline of competence requirements against which proposals for change can be compared.

- The assessment of competence should link into a process of continuous improvement.

In addition, a demonstrable process of competence assessment should enable a Duty Holder to provide assurance to regulators and other stakeholders that a core aspect of their safety case, namely staff competence, is valid. This can be particularly important in those cases where the operation of older plant and equipment, which often fails to meet latter-day operability standards and may lack up to date procedures, is justified on the basis of staff competence. In this way, competence assessment is an essential part of the process of deciding what balance should be struck between supervision, written instructions and staff competence. The results of competence assessment should allow informed decisions to be made regarding what level of supervision and managerial control is required.

Clearly competence assessments comprise just one part of a wider competence assurance process that encompasses training, development and supervision. The place of competence assessment within competence assurance has been outlined in the HSE publication "Developing and maintaining staff competence" (2002). As discussed in the HSE's publication competence assurance starts with recruitment and selection wherein candidates are selected as suitable for an activity or rejected as not suitable. Staff are trained and developed and then submitted for assessment. Some will be competent and others will not yet be competent. Persons not yet competent may be suitable for more training and development, others may no be. Those assessed as competent will be monitored to ensure their competence is maintained via formal and informal monitoring. Persons found to have sub-standard performance may be suitable for development to restore competence and then re-assessed. All staff will be periodically reassessed with further development as necessary.

1.1.4 HSE feedback on current practice

Against this background, it is pertinent to note that, from the experience of HSE Hazardous Installations Directorate inspectors, whilst many organisations have developed job – competence matrices, few COMAH Duty Holders have developed a set of competence assessment methods. The issues of concern include:

- It is common practice to assume a person is competent due to their completion of certain training courses or possession of qualifications and period of experience – without questioning whether the experience provides pertinent exposure to safety critical tasks, whether the training outcome is assessed or whether performance on the job in safety critical tasks was satisfactory;

- Lack of linkage between competence assessment and the COMAH major accident prevention controls;

- Failure to identify tasks (and associated skills and knowledge) that could impact process safety, such as knowledge of safety critical valves, operating procedures etc;

- Adequacy of on-the-job assessment, including the competence, credibility and independence of the assessor, what criteria are applied and the consistency in evaluation criteria;

- A presumption that achievement of general standards such as National Vocational Qualifications is enough alone to assure competence;

- Lack of systematic assessment;

- Lack of ongoing assessment once a person is in post, and;

- Many sites view safety competence as "personal" safety rather than process / major accident safety.

Indeed, the HSE guide "Human Factors for COMAH Safety Report Assessors", produced for use by HSE assessment teams, states:

> "The relevance of training to a safety report is that there should be establishment and assurance of competence specifically for the key responsibilities and for key safety critical and safety related tasks. Too many reports give information just about general safety training which is often more about personal safety than major accident prevention." (p6-7)

The validity of these concerns is reinforced by the findings of this study, as summarised later in this report. Thus, there does appear to be scope for improvement amongst Duty Holders in the practice of competence assessment. In particular, it is important to understand how competence in relation to major accident prevention can be defined, how it can be demonstrated and how companies can ensure that these competencies are maintained.

1.2 OVERVIEW OF THIS REPORT

This aims of this report are to produce (1) an authoritative view of what comprises good practice in the field of competence assessment in relation to major accident prevention and (2) a model of good practice. The report focuses on what needs to be done to demonstrate or assure that a person is competent, rather than evaluate the virtues of associated training and development methods. We have focused on methods for assuring and demonstrating competence is adequate and appropriate for safety critical tasks, particularly operators and maintenance staff, but COMAH does apply more widely such as to managers.

The report has drawn together experience, standards and lessons learnt from a number of high hazard industries, particularly chemicals, offshore, nuclear and aviation. It has also given due regard to the guidance on competence assessment laid out by personnel specialists, national certification bodies and institutes. Thus, the guidance in this report pulls together the good practice in the field of safety management and in the general field of competence assessment.

In addition, the report and associated tools have been scrutinised by six COMAH Duty Holders. Also, the guidance has been presented to a seminar of 60 individuals from COMAH sites during which feedback on the guidance has been solicited. The final version of the report has taken account of their feedback and experience.

The following sections of this report are summarised below.

- Section 2 provides a review of current competence assessment practices and highlights common aspects that Duty Holders may need to improve in the context of the COMAH regulations, along with some examples of "good" competence assessment methods;

- Section 3 outlines an approach to the assessment of competence for the purpose of major accident preventions, drawing on examples of good practice and the requirements of the COMAH regulations and provides a set of guidelines and checklists to help Duty Holders develop appropriate competence assessment methods;

- Section 4 provides a self-assessment checklist to help Duty Holders appraise their current approach to competence assessment, and;

- Section 5 provides a set of examples of competence assessment for a sample of specific tasks that Duty Holders may use as benchmarks.

Appendix A provides summaries of 10 examples of how organisations in a range of sectors assess competence.

As the COMAH regulations cover a wide range of installations, from large refineries through batch chemical plants to relatively small LPG depots and food manufacturers who "incidentally" use hazardous materials, the guidance is intentionally generic. In particular we have aimed to draw out the common factors and principles that underlie the design of competence assessment systems, with sufficient examples and explanation to allow duty holders to apply these generic principles to their own operations.

Given that this report is aimed at companies that may not have access to in-house expertise on competence assessment, the report aims to elaborate the principles of assessment as well as exemplify good practice.

2 A REVIEW OF CURRENT PRACTICE

2.1 INTRODUCTION

This part of the report aims to illustrate and review the current range of approaches to competence assessment in the context of the requirements of the COMAH regulations. The review draws together:

- The human resources and management literature, including guidance from national institutes on competence assessment;
- Feedback and practices at 10 case study organisations, and;
- Publicly available literature on competence assessment in high-hazard industries.

Whilst this study has not included a large-scale survey of current practices, the 10 case studies have been selected to provide an indication of the range of current practices in the onshore hazardous industries.

The approaches and practices have been reviewed against the requirements of the COMAH regulations. Those aspects of competence assessment that could be improved in relation to the prevention of major accidents are highlighted.

2.2 WHAT IS COMPETENCE ASSESSMENT?

The question is often asked "What is meant by competence?" Competence is commonly regarded to be the ability to perform the activities within an occupation or function to the standards expected in employment. This definition makes reference to standards. Thus, competence is equated to an ability to perform to the expected standard. Hence, competence assessment entails measuring a person's performance against a standard.

In the context of COMAH the Hazardous Installations Directorate (HID) of HSE describe competence as the continuing ability of individuals and teams to perform reliably the Major Accident Hazard elements of their roles, responsibilities and tasks, and for this to be demonstrable. Following on from this is the implied need to have a set of competence standards that directly cover the Major Accident Hazard elements of jobs and suitable forms of assessment.

In their guidance on "Developing and Maintaining Staff competence" the HSE state that:

> "Competence-...the ability to undertake responsibilities and to perform activities to a recognised standard on a regular basis. Competence is a combination of practical and thinking skills, experience and knowledge, and may also include a willingness to undertake work activities in accordance with standards, rules and procedures." (p2)

Both the HID and Railway definitions of competence imply that competence assessment is an ongoing process. The railway definition also makes reference to the attitudinal component of competence.

It is also important to note that the definition represents an outcome-based view of competence. It leads to the view that competence assessment entails the collection of sufficient evidence of workplace and / or personal performance to demonstrate that the individual can perform to the specified standard.

This definition of competence is important in two respects. Firstly, it highlights the need to recognise the difference between recording a persons experience / training and actually assessing their competence. Competence assessment requires the collection of outcome based evidence about a persons ability to perform, rather than simply assuming that exposure to training and experience assures competence.

Secondly, this outcome-based view of competence assessment can be compared with the common objectives of selection and recruitment. That is, selection and recruitment processes often aim to assess whether a person has the appropriate underlying characteristics and knowledge for a job. Accordingly they test personality, aspirations, underpinning knowledge and attitudes with the expectation that they will be able to perform competently with the passage of time and appropriate experience and training. Standard selection processes do not necessarily require an individual to be fully competent at the time of appointment. Rather they aim to predict the standard of performance that a person will in time be able to achieve. This highlights the difference between aptitudes and ability, wherein a person can have an aptitude but may lack the ability to apply it to good effect.

These distinctions are important in the context of COMAH, as it is clearly insufficient to assume that a standard selection process (which focuses on aptitude rather than ability) will ensure a person is fully competent. In the context of COMAH, limits may need to be placed on a person's range of responsibilities until it is demonstrated that their range and level of competence is adequate for unsupervised work. In addition, the outcome based definition of competence assessment matches the expectation within the COMAH regulations that Duty Holders will collect evidence of competence rather than assume experience and training is sufficient evidence alone.

2.3 HUMAN RESOURCES GUIDANCE

2.3.1 General principles of competence assessment

Figure 1 provides an outline of the "standard" approach to competence assessment, as defined by defined by Fletcher (2000).

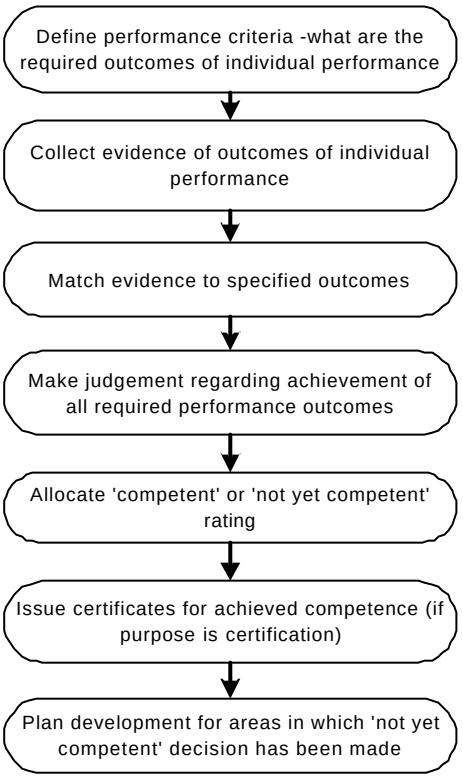

Figure 1 Overview of competence assessment

The figure highlights the view that competence assessment needs to be approached in a systematic manner. Fletcher asserts that to develop an effective process of assessment it is important to determine:

1. What is it we want to assess? Assessment can be looking at someone's ability to learn, or their progress within a development programme, or their on-the-job performance.

2. Why are we assessing? The reasons for carrying out competence assessment can be to identify gaps, appraise performance, carry out a skills audit, support manpower planning or selection & recruitment or the establishment of project teams, or for all of these.

3. Is certification required? There are big differences between the different sorts of certification. However, in terms of competence assessment certification requires more than having attended a training course, i.e. it requires assessment of whether the person can perform to a certain standard.

4. Decide how to assess? For example, do you require a one-off demonstration of performance or do you want to know that people can perform to a specified standard over a period of time? Ideally competence should be based on the outcomes of performance and the assessment of individuals over a continuous period. Behavioural indicators should:

    - Describe directly measurable examples of an individual's competence;
    - Describe one piece of behaviour or evidence;
    - Not be duplicated across competencies or levels;
    - Include a verb clause;
    - Include enough contextual information to make the action credible.

In addition, it is important to consider who will assess competence, particularly in the context of work place assessment. Whilst it is vital that the assessor understands the tasks and functions, it is equally important that they understand the process of assessment and can provide an impartial opinion. Accordingly, it is advised that assessors, including line managers, are instructed in assessment and that, in some cases, an independent person contributes to the assessment.

The forms of assessment commonly used in workplaces are summarised in Table 1. They range from "on the job observations" through the observation of set tasks and oral examination, to written examinations, aptitudes tests and assessment centres. The strengths and weaknesses noted in the table reflect the view that each form of assessment is suitable for one or more situation. For example, on the job observation of performance clearly provides evidence of ongoing competence. However, off line testing on set tasks may be required when observation of normal work is not possible, such as for rare tasks. In addition, whilst on the job observation may detect performance problems it may not reveal gaps in underpinning knowledge, which examinations and oral questioning may reveal. Thus, different forms of assessment may better match assessment of skills / performance versus underpinning knowledge.

Table 1 Assessment Methods (Derived from Fletcher 2000)

Method	Strengths	**Weaknesses**	**Key Issues**
Observing someone carrying out their job.	• Provides high quality evidence • Assessment can be undertaken as part of line manager's job • Individuals become familiar with ongoing assessment • Provides continuous assessment basis • Evidence is produced regardless of whether it is used for assessment	• Opportunities to demonstrate competence across full range of activities may be limited. • Assessors may be too overloaded to carry out assessments • Assessor/assessee relationship • Expensive • Disruptive to the workforce	• Need for trained assessors • Use of multiple assessors • Need for clear lines of communication & QA measures • Need to have a checklist of what to observe
Specially set tasks: skills, tests, simulations, projects, assignments. When normal work activity observation is not possible, special tasks or assignments can be set to generate the required evidence, but need to recognise that this evidence may not be of high quality. E.g. emergency exercises, a wide range of activities, or licensing fork lift truck drivers.	• A useful tool for generating evidence • Can be off-site and therefore avoid noisy or disruptive environments • Test conditions can be standardised for skill tests • Time for testing can be effectively allocated	• Removed from realistic working conditions • Individuals act differently in test situations • Structure of projects or assignments is lose • Difficult to predict the exact type of evidence that will be generated	• Need for planning and structure • Need to ensuring a valid and appropriate simulation

Method	Strengths	**Weaknesses**	**Key Issues**
Oral questioning. To supplement evidence of performance by asking what if questions to find out about performance in a different context or in other circumstances.	• Valuable tool for collecting evidence across full range of activities • Useful to investigate underpinning knowledge • Can be rigorous and standardised	• Assessors often answer their own questions • Not sufficient in itself to demonstrate competence • Least likely to reflect or represent real working conditions	• Need assessors trained in questioning techniques • Requires inferential jump
Written exam	• Valuable for knowledge based activities • Can be well structured to elicit key areas of knowledge and understanding	• Also assesses ability to write and construct written material • Needs skilled assessors to judge • Lacks validity • Time burden for examined and the makers and reviewers	• Danger that 'knowing' is confused with being able to do it • Often unstructured or unplanned • Supplies supplementary evidence of actual performance
Multiple choice papers	• Well designed questions can be standardised • Elicits key knowledge/ understanding in short timescale	• Always a certain probability of the correct answer being chosen at random • Needs careful design • Time away from work is required	• Time and skills needed for design, delivery and marking • Supplementary evidence only – not direct evidence of actual performance.

Method	Strengths	**Weaknesses**	**Key Issues**
Aptitude Tests. Typically include for instance: verbal reasoning, numerical reasoning, logic etc. Useful to determine whether people have the underlying competency to carry out a job.	• Quick and easy to apply • Well designed questions can be standardised	• Always a certain probability of the correct answer being chosen at random • Needs careful design	• Does not provide evidence of actual job performance • Mixed levels of predictive ability these have.
Psychometric tests Tests designed to consider the psychological characteristics of individuals and match these to a particular post.	• Quick and easy to apply • Particularly useful for certain tasks where they are well established and the required characteristics are well established.	• Need certain levels of expertise to ensure that appropriate tests are selected for the post • Needs careful design • Danger that people are labelled • Measure characteristics that influence behaviour but not how a person behaves when using these characteristics.	• Does not provide evidence of actual job performance – not direct measure of competence • Mixed levels of predictive ability these have.
Assessment/ Development centres An amalgamation of many of the methods into a fixed setting and time frame.	• High quality end result • Provides an opportunity for many of the methods to be used	• Can be costly and have high time demands.	• The efficacy depends on the quality of the other assessment methods used.

2.3.2 The role of national standards

In many cases national vocational standards have been developed. A summary of the NVQ process, the most common form of vocational qualification, is given in Box 1. The use of such standards offers some obvious advantages, including;

- Enables assessment of staff against nationally recognised standards;
- Reduces the need for every organisation to develop standards;
- The standards are externally verified.

In some industries competence assessment is based on the use of these standards, i.e. if a person meets a national standard they are assumed to be competent. NVQs can be tailored for specialised activities to provide a benefit to their employees and equip them with a recognisable and transferable qualification. Some examples include:

- National Vocational Qualifications, such as the Board for Education and Training in the Water Industry NVQs for Operating Process Plant and Laboratory Operations;
- Petroleum Industry National Training Organisation standards for Refinery Control Room Operations, Transporting Goods by Road, etc
- Vocational Qualifications in Science, Engineering and Technology;
- Institute for Supervision and Management guidelines on assessment for supervisors.

NVQs can be:

- Generic to an industry;
- Tailored to a specific part of that industry, such as bulk liquid warehousing;
- Tailored specifically to a site or company.

In each case, the standards lay out the minimum range of skills and knowledge required, the assessment methods and required level of evidence of performance.

In some cases these standards have been developed for roles that have an obvious potential impact on safety, such as Refinery Control Room Operations, although their prime purpose is one of personal development and assessment rather than the assurance of safety.

Off the shelf NVQs (generic) are typically used for relatively less complex/risky tasks, such as operation of simple plant and lower hazard plant. Feedback from companies consulted during this study indicates that the process of deciding what level of NVQs to aim for appears to work as follows:

1. Identify tasks wherein error or substandard performance could lead to a hazardous situation / accident?

2. Determine the complexity of the task and match this to an appropriate NVQ level – typically:

    - 1 for very simple low risk operations,
    - 2 or 3 for more complex / riskier operations,
    - 3 for team leader / supervisory roles.

3. Carry through standard NVQ process for these activities.

Bespoke licensing schemes, occasionally using the NVQ process, are typically used for more complex and higher risk tasks, such as control room operations (for complex plant) and supervisors. The licensing process has a different emphasis for operators and supervisors / managers. The licensing of control room operators typically focuses on technical skills and knowledge, whilst the assessment of supervisors also focuses on team management and communication abilities in pressured situations. The exact balance of assessment depends on the level of teamwork / communication required by people.

The potential limitations of national standards in the context of major accident prevention are discussed later in this report. Notwithstanding these limitations it is pertinent to note that the NVQ process has embedded within it the importance of practically demonstrating competence, as well as the process of defining objectives, gathering evidence, comparing the evidence with objectives, and finally making a judgement on competence.

Box 1 – National vocational qualifications

NVQs are divided into five levels:

Level 1 – Foundation skills in occupation

Level 2 – Operative or semi-skilled occupations

Level 3 – Technician, craft, skilled and supervisory occupations

Level 4 – technical and junior management occupations

Level 5 – Chartered, professional and senior management occupations

NVQs comprise:

- **National Occupational Standards;** statements of performance that describe what people in a particular occupation are expected to be able to do. They cover current best practice, the ability to adapt to future requirements and the knowledge and understanding that underpins competent performance.
- **Units of competence;** descriptions of the different functions that people perform**.**
- **Elements of competence;** detailed descriptions of the standard of performance expected
- **Performance criteria** to assess if the person meets the National Occupational Standard

- **Knowledge requirements** that describe what the person needs to know to perform to the National Occupational Standard

- **Evidence requirement;** descriptions of the evidence people must show to prove to an assessor that they are competent.

Assessment is normally through on-the-job observation and questioning of underpinning knowledge, understanding and work-based performance. Assessors are either in-house employees that have been trained or external assessors.

2.4 SAFETY RELATED COMPETENCE ASSESSMENT

It is clear from the overview of general guidance on competence assessment, that competence assessment is meant to be a systematic process wherein performance standards are based on an analysis of task or function specific requirements, evidence is collected by appropriate methods and compared against performance criteria. Review of current practices within and outside the onshore hazardous industries indicates that there is wide variation in the standard of competence assessment. This section of this report outlines the main findings from a small scale survey of current competence assessment practices in 6 onshore hazardous installations and a review of practices in other sectors noted in publicly available literature and a further 4 case studies in the aviation, nuclear, power supply and offshore sectors.

2.4.1 Case Studies

There is considerable variation in the types of approach adopted by firms operating onshore hazardous installations. In some cases Duty Holders have developed systematic approaches to competence assessment and even made explicit links between the COMAH safety report risk assessment and competence assessment. In other cases reliance is placed on unstructured peer review. These variations are outlined below.

Identifying and defining safety critical competences

One of the key points within Human Resource (HR) guidance is the importance of using task analysis for clearly identifying tasks to be carried out, and further to produce standards for performance assessment. Three of the surveyed onshore companies have used some form of tasks analysis in order to identify safety critical task and define the correct way of working for use in assessing their staff. For example, a refinery has carried out Hierarchical Task Analysis of tasks, wherein critical operations are broken down into task stages and procedures and individuals are then assessed against these standards. This produces an effective task inventory from which can be produced a standardised system of competence assessment. Assessors can then test a person's knowledge by asking them how they would carry out a particular task and probe their understanding of (say) the safety function of equipment and key safety procedures. In these cases the task analyses cover operational activities, such as process operations, thereby providing a basis on which to assess staffs' technical and procedural knowledge.

Indeed, in two of these companies individuals are given a certain status on the basis of how competent they are to carry out safety related tasks. One of the companies has also recently

developed a system in which, after initial training, individuals then move into another period of training in which their competence is then assessed to carry out tasks that are specifically related to their job, they have to be further trained if they need to be involved in tasks that have particular safety significance.

However, two other surveyed onshore companies have no systematic approach for defining tasks. There is a commitment in some companies to clearly define the tasks that individuals carry out, however many of the companies do not have a standardised system of competence maintenance, after training periods have been completed. It is apparent that in practice many companies do not make a distinction between training and assessment.

Methods of assessment

The most frequent method of competence assessment was that of 'observational assessment' from an online supervisor or appointed trainer. Individuals tended to be deemed competent on the basis of trainer or supervisor satisfaction. In some cases the assessment of operators and maintenance staff rely on unstructured on-the-job review, a practice considered as poor by this study. However, in some companies this judgement is guided by the use of validated task descriptions, task based skill and knowledge inventories, verbal test questions, and guidelines on (for example) the number of times a person needs to correctly perform a task to be deemed competent.

Also, in the case of safety critical emergency roles, such as control room management of process upsets, there are examples of the application of "best practice" forms of assessment, such as the systematic use of simulator based assessment of decision making and command skills. Finally, in some cases the issue of assessor competence has been addressed by the use of trained assessors.

Skill decay

The literature emphasises the importance of practice in order to maintain skills and also comments on how some skills may decay with time. In practice refresher training is not always recommended, and some companies do not have a standardised system of ensuring competence is maintained over a prolonged period. Companies on the whole do not appear to proactively guard against the potential for decay in the ability to do tasks. This can be contrasted with the aviation sector wherein pilots are required to be reassessed every six months in order to ensure that they are competent to carry out everyday tasks. Furthermore there is a requirement to fly a certain minimum number of hours in a given period.

NVQs

The HR literature emphasises the use of the NVQ system as a means of assessing the competence of individuals to carry out tasks. In particular the literature states that NVQs have systems for practically demonstrating competence to carry out particular tasks, as well as the process of defining objectives, gathering evidence, comparing the evidence with objectives, and finally making a judgement on competence. There are examples of the NVQ process being effectively used to set standards for maintenance staff and to facilitate their assessment. In these examples the standards tend to focus on the technical knowledge and skills required to maintain plant (in a safe state). This would include knowledge of safety procedures and how to maintain equipment with safety functions, such as pressure relief valves.

However, in practice some companies do not try to follow the NVQ format as there is no way of specifying the hazards related to the tasks that are being assessed. Other companies found that the NVQ system did not cover assessment for competence in all tasks, omitting tasks that individuals would be required to do. Thus, although there were examples where NVQs were seen in a positive light, such as for maintenance staff, there is clearly recognition in industry of some of the drawbacks in using NVQs, and companies are questioning the methods they are using to assess the competence of individuals to carry out safety related tasks.

Linkage to COMAH requirements

There are examples of companies addressing the needs of COMAH safety cases in various ways. Some companies make an explicit link between the risk assessments results and competence assessment by using the accident scenarios in safety cases as the basis on which to assess individual competence, as in simulator based control room operator assessment. An example of this is a major refinery that uses the safety cases from companies to provide simulator-based training in event management.

Some companies carry out a form of risk assessment to identify safety critical tasks for which they require assurance of staff competence. The main example of this is a major refinery that uses task analysis and other safety assessment methods to identify the safety criticality of the task in order to provide a standard system of competence assessment. At the other extreme a chemicals manufacturer would not see the relevance of linking COMAH to a competence assessment scheme, seeing COMAH as highlighting what they would describe as 'unlikely' hazards. They would link competence assessment to what they would regard as more likely hazards.

Most companies have made provisions to have competent trainers assessing individuals in carrying out their tasks. This ties in with the COMAH requirement. Furthermore, most companies have clear selection phases in which they are recruiting the correct individuals to carry out tasks, this is also a COMAH requirement.

However the link between COMAH and competence assessment tends to become less clear when competence assessment and re-assessment are considered. Some companies tend to use 'direct observation' by a competent individual as the main form of assessment. As previously mentioned, such observation is often unsystematic. In addition, one company cited problems in developing a standardised assessment tool for assessing individuals in the area of event management. This is due to the uncertainty of what may be a valid form of competence assessment for event control performance. One issue, is that the actual task of event control is very dependent on decision making ability, and there are many tasks which the individual needs to be able to perform in order to manage an event, this therefore makes competence assessment difficult. Accordingly, this leads to questions over whether this form of assessment meets COMAH requirements by ensuring that individuals are capable of carrying out the task safely with the appropriate skills and knowledge.

COMAH also requires that companies need to provide refresher training and reassessment opportunities, particularly for tasks that are performed infrequently (e.g. Event Control). Companies tend not to have standardised systems in place to allow for the reassessment of individuals, relying mainly on annual peer review systems.

Thus, it appears that there is a variable level of achievement of COMAH requirements, although some case studies companies can cite examples of good practice.

2.4.2 Competence assessment in other high-hazard sectors

The review of practices in other sectors highlights a number of key points regarding the management of competence assessment and the methods of assessment. First, there are examples of competence assessment being managed as part of a cohesive, planned and managed process. In particular, the nuclear sector has developed a process of competence assessment with the aim of ensuring Suitably Qualified and Experienced Personnel (SQEP) perform all tasks. The term SQEP is used to denote the status of an employee as being competent. A competence – job matrix is used to determine competence requirements for each job against which staff are assessed.

Another example can be found in the aviation sector wherein there is a set of training, experience and assessment requirements for pilot qualification covering initial appointment, progression from one grade to another, transfer between aircraft types and ongoing competence assurance. Individuals must demonstrate knowledge of air law, meteorology, navigation and aircraft performance. They also have to complete exams that relate to the specific type of aircraft that they are being trained to fly. Furthermore, individuals have to go through practical flying training and simulation tests, and are required to complete a specific number of hours flying for each licence. The range of tasks and knowledge required of pilots is laid out in a set of standards.

After pilots have moved through the process of initial selection and training they are then into what the airline industry describes as the 'check and train' phase, this system is conducted under the Air Operators Certificate (AOC) who require individuals to go through a system of regular retraining. Pilots are reassessed every six months in the check and train phase, and at this assessment the pilots will have there skills monitored in a simulator or live aircraft. Typically competences measured include the following skills and underpinning knowledge:

- Knowledge of specific aircraft systems;
- Knowledge of operational rules and guidance material;
- Knowledge of handling skills for the aircraft;
- Ability to handle a range of emergencies;
- Ability to handle systems failures.

Methods of competence assessment

There are also examples of how to assess the softer competencies entailed in emergency response and the technical / supervisory competencies entailed in managing safety critical activities.

Emergency response management competence assessment

The assessment of offshore installation managers, air pilots and submarine commanders provide examples of how to assess the competence of emergency response roles. In particular, these examples entail:

- The use of simulators and exercises based on accident scenarios taken from risk assessments;
- The use of behavioural checklists by observers to guide the assessment of performance on "softer" competencies such as delegation, communication, decision making under stress, information acquisition etc;
- A series of 'standards of performance', 'evidence requirements' and 'underpinning knowledge and understanding' that individuals need to meet;
- Re-assessment at regular intervals (every 6 months for pilots and every 1 to 3 years for OIMs).

The method of assessment in these examples has many parallels with those used in the field of Crew Resource Management, as discussed in Box 1. The use of behavioural markers for a pre-defined range of core behaviours enables assessment of the "softer" behavioural competencies considered to be essential for the prevention of error in emergency control activities. Such behavioural assessment compliments the assessment of technical skills and knowledge via exams, flight simulations, review of probationary periods of work and verbal examination.

Box 1: Crew Resource Management

Crew Resource Management (often referred to as Line Oriented Flight Training in the UK) was developed in response to the recognition that air pilot error and behaviour was a major factor in crashes. In particular, it was recognised that behaviours such as task delegation, solicitation of information from co-pilots, effective communication and task shadowing were critical. Accordingly, a range of training schemes have been developed with the aim of developing pilot's awareness of these behaviours, assessing their behaviours and improving their skills. These competencies are typically sub-divided into categories of behaviours, such as:

- Cognitive competences such as problem identification, situational awareness, distraction avoidance, task prioritisation, self-monitoring of critical decisions, decision-making and workload management (including task delegation);

- Interpersonal competences such as team management, team adaptability, crew coordination, team performance monitoring, group climate, conflict resolution, crew communications (including inquiry, advocacy and assertion).

These competencies are typically tested using simulators, with competent observers (usually training captains) judging individual's performance, and during in-flight assessments. Some companies have been developed schemes to support the assessment of individual's competencies. These schemes comprise "checklists" of behavioural markers that denote and define observable set of behaviours that are taken to be indicative of aspects of performance. Typical behaviours are listed in relation to component skills and thence used to assess the non-technical elements of competence. Some examples of behavioural markers are given below:

- Did the Captain seek inputs from other members of the crew (about the event)?
- Did the crew annunciate problems when they occurred?
- Did the Captain communicate a decision?

Each behavioural marker is usually restricted to a single behaviour for ease of measurement. A scale may be used, such as Unacceptable, Minimally Acceptable, Standard, Above Standard, Excellent, by observers. Whilst practices vary, most companies who use this form of assessment retrain individuals who either fail or gain a poor assessment and then reassess them. In some airline company pilots can fail a check based on their CRM skills.

Observation based assessment can be complemented by verbal examination of individual's understanding of and attitudes towards these behaviours. For example, they may be asked "What are the components of a briefing that is operationally thorough and interesting and addresses coordination, planning and problems? Attitudes may be probed by questions such as "What is your feeling towards the relationship between inquiry and advocacy and the captain's authority?" Thus, performance based assessment of competence can be combined with a systematic probing of individuals knowledge of and attitudes towards key behaviours.

The principles and techniques of Crew Resource Management are now used to varying degrees in many sectors, including the medical, offshore oil and gas, nuclear and aircraft maintenance.

Supervisors' competence assessment

Case Study I considers the process of assessing staff for the role of Senior Authorised Person with responsibility for setting up and supervising staff completing work on high voltage equipment. The process includes:

- A set of core skills and underpinning knowledge are laid out including; ability to produce risk assessments, competence to set people to work safely, competence to achieve safety when working on low voltage and high voltage systems, and competence to establish general safety;

- Defining a set of technical qualifications required to demonstrate possession of underpinning knowledge, including HNC, NVQs and industry specific certificates;

- A verbal examination of how people provide appropriate leadership in certain situations, such as unsafe work, and review of samples of past behaviour;

- Verbal tests of system specific knowledge, such as asking people to isolate (on paper) a high voltage circuit;

- Requiring a suitable period of experience, including experience on protection and control systems;

- Successful completion of a course focusing on "how to set people to work safely", including successful (as judged by an observer) management of a piece of work from a work package, ensuring all safety documents are applied in the correct way, and that the staff they are supervising are set to work safely;

- Each year SAPs are reviewed by their line manager and have to sit a computerised test of their knowledge of specific safety procedures and instructions, and;

- Individuals are refresher trained every 3 years and at this stage they are given a computer based assessment exercise and a pen and paper test.

This example illustrates a systematic approach to identifying and assessing the technical and supervisory competences required of people managing safety critical activities.

2.5 DISCUSSION

2.5.1 Comparison of safety and general HR practices

In many ways the approach to the assessment of competence in safety critical roles does and should mirror the approach advocated for competence assessment in general. In particular, the concept of collecting evidence of performance, the need to set performance criteria, independent and competent assessors and the use of standards outlining key skills and knowledge are all equally pertinent. However, it is apparent that there are some particular requirements and practices in the context of major accident prevention. These include:

- A need to ensure that the process of competence assessment is managed in a systematic and proactive manner to a standard commensurate with the goal of preventing major accidents;

- High-risk industries tend to place more emphasis on certain forms of assessment due to the relative importance of certain types of tasks and the need to provide a particularly high level of competence assurance for safety critical roles. In particular, high-risk industries tend to place more emphasis on:

    - The role of risk assessment in identifying competence needs.

    - The use of task analysis to identify the skills and knowledge entailed in complex technical tasks, such as control room operation, developing safe systems of work, equipment maintenance and emergency management.

    - The development of techniques, such as the use of behavioural markers to assess communication skills in emergencies, for assessing "soft" team management skills when under stress is of particular importance in the field of major accident prevention, obviously due to the importance of team work in emergencies;

    - Licensing – again reflecting the need for a high level of assurance and very high standards of competence in safety critical tasks, such as control room operations and emergency response;

    - The role of simulators and exercises, due in part to the rareness of emergencies but again reflecting the importance of assessing competence for handling emergencies and rare events;

    - The need to monitor, maintain and improve competence, in particular recognising the need for skills to be maintained to handle infrequent events and to ensure staff maintain technical skills and knowledge to operate processes and equipment.

Thus, whilst there are many commonalities between "standard" competence assessment and assessment for safety critical tasks, the characteristics of high hazard tasks and the need for a high standard of assessment do mean that specific attention must be awarded to the design of competence assessment for major accident prevention.

2.5.2 Areas for improvement

Whilst this study did not set out to complete a comprehensive survey of companies, feedback from Duty Holders and our review of their practices does highlight some priority areas, including those noted below.

- A more consistent integration of competence assessment into wider safety management systems, along with the development of standards to ensure a systematic approach;

- Ensuring assessment covers the full scope of safety critical tasks, such as process upsets and shutdowns;

- A wider application of risk assessment for the purpose of identifying and prioritising safety critical tasks for which competence needs to be assessed;

- A higher focus on standard setting and a better definition of the criteria by which staff performance is to be judged, especially during on the job assessment (such as a comparison

against task steps laid out in standard operating procedures and / or examination of staff awareness of the safety implications of tasks);

- Ensuring that NVQ syllabus clearly denotes the major hazard consequences of tasks and the safety role of equipment and is tailored to the needs of the site;

- Ensuring that NVQs are tailored to the major hazard safety demands of specific processes and cover the particular safety issues of that process;

- A greater focus on actual performance within the process of competence assessment;

- Greater attention to the competence of the assessor and the performance criteria they apply, especially during on the job assessment;

- Wider consideration of the potential for skills to decay or become outdated, and therefore the need to consider effective reassessment systems for people carrying out safety related tasks, such as adopting a “check and train” process for staff, perhaps linking this to existing schemes such as annual reviews;

- As part of ongoing assessment, there is a need to better understand what is an appropriate period for reassessment, and how this links to safety criticality of tasks, the frequency with which tasks are carried out and the rate at which skills may decay.

The next section of this report provides a framework for the management of competence assessment.

3 COMPETENCE ASSESSMENT FOR MAJOR ACCIDENT PREVENTION

3.1 AIMS OF COMPETENCE ASSESSMENT

The purpose of the Major Accident Prevention Plan and Safety Management System is to bring rigour to the management of human activities to keep major hazard risks As Low As Reasonably Practicable (ALARP). Therefore, competence assessment, in the context of preventing major accidents, should aim to:

- Provide a comprehensive set of standards against which to judge competence. This may be achieved by:
    - Identifying all tasks wherein sub-standard performance could contribute to a major accident;
    - Providing a valid and complete description of correct task performance against which to assess people;
    - Defining the competences required to complete tasks and the standards of performance for each competence;
    - Providing assessors with a practical set of criteria by which to judge competence;
- Ensure the competence assessment method provides an accurate measure of each type of competence, such as using verbal or written tests to examine knowledge versus using task observation for (say) manual skills;
- Have a planned approach to reassessment of people in post, and;
- Ensure that assessors possess sufficient knowledge of the subject matter and training in assessment to make a valid and accurate assessment of competence.

As part of this, competence standards should:

- Allow for the wider support provided to people by procedures and supervisors;
- Allow for variable levels of experience and responsibility of individuals, and;
- Consider the level of error tolerance in tasks, such as the level of hardware interlocks and engineered safety systems.

Thus, a lower standard of competence amongst newly appointed operators may be balanced by a higher level of supervision, for example. At the same time it is important to ensure that competence standards are realistic and achievable. It is inappropriate to try to compensate for inadequate levels of supervision, plant design and safety controls by placing a requirement on staff to achieve unrealistic performance standards.

Also, whilst use should be made of national standards, it is necessary to ensure that the implementation of these standards is tailored to the site or process specific equipment and hazards.

3.2 OVERVIEW OF ADVICE

The general concept is presented in the form of a sequence of work in Figure 2. Table 6 at the end of this section provides an example of the outcome of this process. In order to develop a process of competence assessment, it is necessary to answer the following points:

- What competencies need to be assessed to ensure that error or sub-standard performance will not contribute to a major accident?
- Are the competence expectations realistic?
- What assessment criteria and competence standards, including what level of performance evidence, are required to ensure risks are ALARP?
- What method(s) of assessment are required to acquire evidence of competence?
- What qualifications and experience do assessors need?
- How often should performance be reassessed, reflecting the level of risk and possibility of skill decay?
- What method(s) of reassessment are needed?

Accordingly, it is envisaged that competence assessment commences with the identification of safety related tasks using techniques such as risk assessment and task analysis. Such an assessment should cover all forms of activity, including normal process operation, process upsets, planned and unplanned maintenance. However, before proceeding to the selection of assessment methods, it must first be established that the performance expectations for staff are reasonable. For example, is it credible that an operator can correctly respond in a timely manner to a process upset given the particular set of controls and response time? Next, a set of performance standards and assessment criteria are defined. These standards may be set in-house or by tailoring national standards. This entails analysing the types of competencies required, describing what comprises adequate performance and defining measurable criteria by which to judge performance. Higher levels of evidence are required for higher risk activities. Once the task and type of competences are understood, an appropriate type of assessment method can be identified. Finally, the ongoing "competence checking" needs are determined by consideration of how competencies may decay over time and the safety criticality of the task. This entire process is managed proactively as with any other aspects of major accident prevention.

Table 2 provides a summary of the questions that need to be asked to devise an appropriate form of competence assessment.

The following section of this report provides a set of checklists, guidelines and examples to support the implementation of this framework. As this report is aimed at the whole range of activities covered by the COMAH regulations, ranging across different industries processes and activities, the advice is necessarily generic. The advice aims to illustrate principles, key factors

and common practices. Reference is also made to some examples of current standards and schemes used within industry. Section 4 of this report provides a self-assessment checklist to help judge the extent to which a site already achieves this process of competence assessment. Section 5 of this report provides four task specific examples of competence assessment whilst Appendix A outlines the approach to competence in 10 organisations. Case studies A, B, E, G, I and J have examples of good practice drawn on by this report.

Figure 2 Overall competence assessment framework

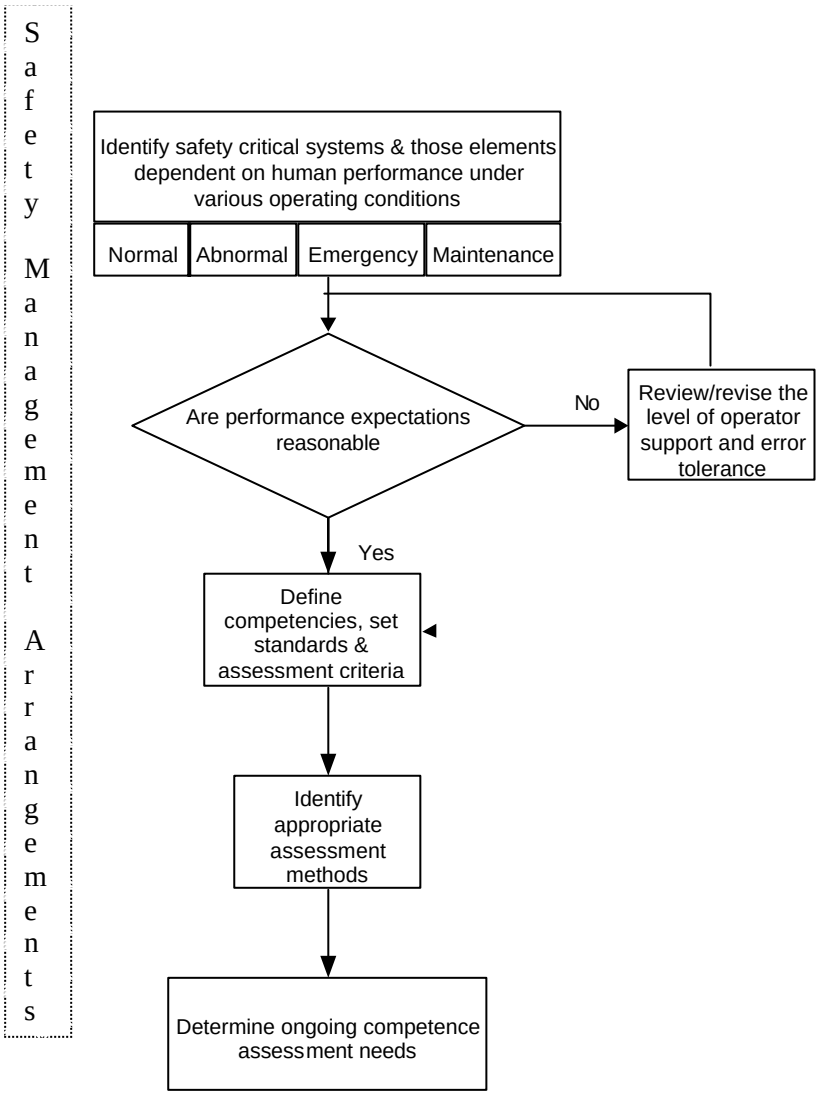

Table 2 Checklist competence assessment issues

Safety criticality			
In what way may sub-standard performance in this task contribute to a major accident?			
What is the level of safety criticality?			
Type of competence			
Does this task require:	Yes	Somewhat	Not significantly
• Physical and / or sensory motor skills, such as knowing by "touch" the correct torque on a bolt.			
• Procedural skills, i.e an ability to remember and enact prescribed procedures / rules.			
• An attitude of safe working and adherence to safe working practices.			
• Cognitive skills such as diagnosis of faults, decision making.			
• Knowledge of how plant / processes work and its hazards.			
• Supervisory skills, such as work planning, prioritisation, delegation, coaching etc.			
• Teamworking, communication etc behaviours			
Task complexity and redundancy			
Is this a complex task?			
Is there a high level of defences against error, such as redundant safety systems, constant supervision, interlocking, that would prevent an error contributing to a major accident?			
Is it possible, for this task, to compensate for gaps in skills and knowledge through supervision and / or other forms of on the job support?			

Assessment method			
Can this task be observed during normal operations / maintenance?			
Is it safe to make an error during an assessment "on the job"?			
Are there formal qualifications and training courses that can be used as indications of underpinning knowledge and skills?			
Assessor competence			
Does the assessor need to have:			
• A clear understanding of the correct procedure of operation?			
• An up to date understanding of the process and its hazards?			
• A clear understanding of what comprises effective supervision / interpersonal / teamworking skills?			
• Training / accreditation in assessment?			
Ongoing assessment			
Is it likely that skills and knowledge may decay within a couple of years, eg due to lack of practical experience?			
Does normal day-to-day work provide evidence of ongoing competence for this task?			
Is it likely that procedures, equipment and plant will change within…	Every year	Every few years	Less frequently
What operational and /or safety measures are available to monitor on the job performance, such as near miss reports and SHE audits?	Write in:		

3.3 MANAGING COMPETENCE ASSESSMENT

As with all aspects of major accident prevention plans, competence assessment should be managed in a planned and proactive manner. Key elements include:

- Including competence assessment within training, selection, recruitment, promotion and ongoing "on the job" appraisal as a matter of policy;

- Ensuring appropriately qualified and experienced persons with sufficient time are available to complete competence assessment;

- Having a planned and comprehensive process of competence assessment (as elaborated in the remainder of this section), that covers all safety critical activities and provides a set of performance standards;

- Linking competence assessment into the process of setting levels of supervision / training, management of change, staff management, procedures development and process safety engineering;

- Cascading of competence assessment requirements to sub-contractors involved in safety critical work;

- Auditing and monitoring the process of competence assessment in the same manner that other elements of safety management should be audited and reviewed – to aid this the completion of and results of competence assessment should be recorded, and;

- Reviewing the adequacy of the competence assessment process in the light of new developments, accident analyses and safety performance, including reviewing whether the results of competence assessment match the actual standard of staff performance.

An example that exhibits some key aspects of the process for managing competence drawn from the chemical processing sector is given in Box 2.

Box 2: Suitably Qualified and Experience Personnel system

The nuclear sector has developed a process of competence assessment with the aim of ensuring Suitably Qualified and Experienced Personnel (SQEP) perform all tasks. A competence – job matrix is used to determine competence requirements for each job against which staff are assessed. For all roles there are clear definitions for the following:

- Post title
- Grade of post
- Purpose of post
- Organisation
- Duties and performance criteria
- Underpinning knowledge
- Non-technical competencies
- Training
- Medical Status

The SQEP assessment should cover the following areas:

- Performance of the task (or where agreed, the individual may supply diverse evidence that satisfies the performance criteria);
- Any underpinning knowledge and plant specific/safety topics;
- The range of the duties, roles or tasks.

Individuals are assessed as 'competent' or 'not yet competent' to carry out tasks. All decisions are given to the training department for recording on their training database. All decisions are recorded on SQEP assessment forms. Individuals have an annual review process that can identify the need for reassessment for SQEP status. Training plans for particular jobs can also state reassessment frequency for particular tasks. The timing of the reassessment is based on how complex the task is and how frequently the task is preformed. The same assessment process for the initial assessment is used in the reassessment.

Finally, the level of staff supervision is linked to their competence assessment, in that higher levels of supervision are required for persons assessed as having a lower level of competence. This again illustrates how the competence assessment process is integrated into the wider safety management system.

3.4 IDENTIFICATION OF SAFETY CRITICAL TASKS / JOBS

3.4.1 What is a safety critical task?

In the context of the COMAH regulations, a safety critical task or job is any task wherein sub-standard performance could contribute to a major accident. Some examples of such tasks are given below. Consideration should be given to all categories of staff and modes of operation. For example, operators, maintenance, supervisors and managers may all be involved in safety critical activities. As regards modes of operation, consideration should be given to routine tasks such as operating or maintaining a storage tank, less frequent tasks such as process start-up or plant overhaul, and tasks arising from abnormal or emergency conditions, such as process upsets, fires and toxic gas leaks.

Box 3: Examples of safety critical tasks

- Tasks wherein an error could lead to an unsafe condition, such as leak of toxic chemicals, wrong batch reactor setting, wrong hose connection etc;
- Tasks related to the identification of unsafe conditions, such as fault detection, pipeline inspection etc;
- Tasks related to the recognition and management of unsafe conditions, emergent and actual emergencies, such detecting a runaway reactor process;
- Specific safety tasks such as chemical hazard assessment, process safety assessment, devising safe systems of work etc;
- Safety management tasks, such as supervision of permit to work systems.

3.4.2 To what extent is this task or job safety critical?

This question presupposes that a higher level of assessment is required for those tasks or posts wherein an error or sub-standard performance could cause or contribute to a major accident. In the context of COMAH, rigorous competence assessment is not a priority for tasks such as catering, cleaning vessels of non-hazardous products etc. Indeed, in the case of COMAH the priority is with major accidents rather than occupational health and safety, such as personal injury from the use of vibrating equipment. Accordingly it is necessary to ask whether an error could lead to or contribute to a major accident, such as a leak of toxic material, fire / explosion, runaway reaction etc. For example:

- Could the error initiate an incident, such as fitting a wrong seal to a pump?
- Might the operator fail to spot an overflowing storage tank?
- Could the operator fail to respond correctly to a process upset?

This question should be asked of tasks with and without engineered safety interlocks and engineered safeguards, particularly if the safety report gives credit to the actions of personnel or if safety is premised on the notion that staff are competent.

3.4.3 Identifying safety critical tasks

There are a number of ways of identifying safety critical tasks, including:

- Reviewing the results of a HAZOP, What –if analysis;
- Review of the major accident scenarios and initiating events within safety reports;
- Task analyses of activities;
- Job analyses.

It is important to note that this analysis may commence by reviewing jobs rather than tasks. For example, a list of jobs, such as effluent plant process operator, fitter, technician, shift supervisor could be produced and screened.

Task analysis entails decomposing functions / activities into sub-tasks, and then judging the safety criticality of sub-tasks. The task analysis can be cross-referenced to a risk assessment and / or the safety case to ensure all safety critical activities are identified. In the case of operational and maintenance activities, the task analysis may include an analysis of errors and their consequences – thereby identifying safety critical tasks. Similarly, job analysis entails decomposing a job down into functions and then judging their safety criticality.

Alternatively a risk assessment or risk ranking exercise may identify safety related tasks/activities. In addition, the COMAH safety report should provide a list of emergency scenarios and process abnormalities that can be used to generate a task inventory.

In principle the analysis should cover all tasks carried out on a site that could contribute to a major accident, such as:

- Normal operations, process start up and shutdown;
- Developing safe systems of work, instructions, procedures, plans etc;
- Plant and equipment design and configuration;
- Handling process upsets;
- Routine inspection, maintenance, commissioning and major overhauls;
- Transportation;
- Emergency response.

Which ever approach is taken, it is important to involve the workforce to ensure the analysis is comprehensive, valid and is accepted by the workforce.

Task / Job Inventories

At this stage the analysis may simply provide an inventory of those tasks, jobs or activities for which competence assessment is required in the context of major accident prevention

3.5 COMPETENCE STANDARDS AND ASSESSMENT CRITERIA

3.5.1 Format of competence standard and assessment criteria

The assessment of competence should be supported by a set of standards and performance assessment criteria. A competence standard needs to:

- Provide a testable statement / description of a competence;
- Define measureable criteria for judging performance;
- Specify what level of performance evidence is required for a role, taking account of the individual's status (eg a supervised fitter versus an unsupervised technician);
- Reflect the type of competence in question, specifically skills versus knowledge versus behaviours.

These standards may comprise industry wide schemes such as NVQs but good practice entails ensuring that industry wide standards have been tailored to include the company and process specific competence needs. Thus, the range of tasks covered by bespoke or tailored national standards should have due regard to the results of site or process specific task and risk assessment. It is considered unlikely that any national VQ will be sufficient on its own and will need to be tailored to reflect site specific hazards and processes.

3.5.2 Task and knowledge descriptions

Competence assessment requires a valid and comprehensive description of tasks to be available. The task description should provide a view of:

- The correct way of doing a task (against which a person's performance can be judged), and;
- Key competences (Skills, behaviours and underpinning knowledge).

It is important to understand how far a task needs to be decomposed and at what level of detail it needs to be described for the purpose of supporting competence assessment. The task need only be decomposed to a level that enables the production of testable task / competence descriptions.

Such a task description may be developed by the use of task analysis. At this stage, the task analysis would go beyond a task inventory and actually describe the task and its component competencies.

In the case of common operational and maintenance activities, an up to date and validated operating procedure may provide a suitable task description.

In the case of tasks such as emergency response and supervision, the task description should cover the "softer" (non-technical) competencies of team management, communication, event recognition, delegation and so on.

In the case of underpinning knowledge, the description tends to be in the form of a "syllabus" or its equivalent, such as qualifications.

3.5.3 Identifying and defining key competencies

As befits the task, competence standards tend to cover:

- Skills, such as being able demonstrate an ability to (say) interpret process instrumentation readings, diagnose faults, operate controls, enact a procedure;

- Underpinning knowledge, such as understanding the major accident hazards associated with the process/ equipment / plant and understanding of correct operating procedures and practices;

- Safety behaviours and attitudes, such as safety leadership, communication, teamwork.

In the case of supervisory roles, competence assessment extends to the "safety" procedures such as risk assessment, development of safe working practices, effective communication of instructions/ procedures, effective safety leadership, etc.

Table 3 provides a set of questions that aim to help identify the types of competences required by a task or activity.

Table 3 Defining competencies

Type of skill / knowledge	**Characteristics**	**Task examples**	**Yes**	**Partly**	**No**
Physical and sensori motor skills (visual, auditory, touch, etc)	Physical skill • dexterity • strength • visual skill • manual co-ordination • endurance • kinematic skills	Manual valve operation Use of a control or tool Connecting hoses / pipes Driving Remote robotics control Tightening a manual valve.			
Ability to carry out a prescribed procedure of work	Does this task require an ability carry out a prescribed procedure of work and / or work within a set of operating rules?	Enact operating or maintenance procedures. Operate a process within prescribed temperature / pressure limits.			
Cognitive skills	Does this task require the person to: • Acquire and assimilate information • Interpret a body of information • Make decisions • Detect errors (of own errors) • Prioritise & plan	Emergency management Fault diagnosis / alarm handling Managing process upsets Process design/ hazard analysis Devising operational procedures			

Type of skill / knowledge	Characteristics	Task examples	Yes	Partly	No
Knowledge of equipment, plant and processes	Does this task require knowledge of: • Hazards • Processes and equipment • Operating rules and limits • How things work	Emergency management Fault diagnosis Managing process upsets Process design Devising operational procedures Selecting the correct procedure (eg for repairing a fault, for managing a process upset)			
Interpersonal skills	Inter personal skills • Communicating safety critical information • Soliciting information • Clarity of language • Active listening	Supervising a team of people Checking the adequacy of a colleagues work Co-ordination of an emergency response Safety briefing			
Team management skills	Team management • work distribution / delegation • influencing • achieving common purpose • co-ordination • error detection	Team leaders Supervision Co-ordination of an emergency response			
Safety attitudes and behaviours	Attitudes / behaviours • awareness of safety priority • appreciation of standards • awareness of own limits	All safety critical tasks			

3.5.4 Setting the standard and assessment criteria

Typically it is envisaged that more rigorous assessment and higher performance standards are required for tasks that pose a higher risk, are more complex and have lower levels of error tolerance and supervision. For example:

- Is it essential to be assured that the person is fully competent in all aspects of the task before they are allowed to take up the role, or is there room for a large degree of "on the job learning"?

- How much of the job needs to be examined to get a reliable demonstration of competence? For example, is it adequate to sample each area of knowledge or is an exhaustive test of each type of skill/ aptitude required?

- Is it necessary to secure a "high pass" mark before embarking on the role, or can the person develop skills incrementally?

- What allowance can be made for on the job supervision?

Table 4 provides illustrative advice on how to match the assessment standard to the safety criticality of the task.

Table 4 Matching level of assessment to safety criticality

Safety criticality	Assessment standard	Examples
Highest	Assessment needs to establish ability of individuals to complete all safety tasks without committing errors, before they are authorised to commence work unsupervised. As the tasks are complex and unsupervised the individuals need demonstrate ability to work unassisted and to have full knowledge of how the system operates.	Licensing and certification regimes using written examinations, simulator and shadowed on the job working. Requires assessment in all safety critical tasks and procedures prior to working unsupervised.
Moderate	Need to demonstrate error free performance in a sample of tasks and possession of underpinning knowledge.	May combine prior qualification and experience with sample-based tests of knowledge and observation of skills.
Lowest	Need only demonstrate ability to follow procedures and complete basic task steps. Prior qualifications and experience used to establish cognitive skills or underpinning knowledge.	Check of prior experience, qualifications and on the job observation.

Safety criticality of the task

For the most safety critical tasks, such as responding to a major incident, assessment may be required of all (say) categories of emergencies, such as fire, explosion, gas leak rather than just a sample of scenarios. Similarly, where all parts of an operation are deemed to pose a particularly high risk, assessment may be required on all steps. Inc contrast, assessment of a range of less critical tasks may be restricted to a sample of procedures and underpinning knowledge. Similarly, there may be a greater readiness to accept prior qualifications and experience as evidence of underpinning knowledge and skills, as opposed to a bespoke assessment, in the case of lower risk tasks.

There are few formal precedents for grading the safety criticality of tasks. However, there are examples of risk ranking schemes where tasks are graded from Very High to Low risk on the basis of risk assessment.

How complex is the task?

It is expected that a higher level of assessment is required for more complex tasks. Examples of simpler vs more complex tasks are given below. There are two options when a job entails a range of tasks, of varying complexity. First, the question could be answered on the basis of what is the most complex task, i.e. are all tasks simple or are some of intermediate complexity. For example, a process operation job may entail "simple" tasks such as following a standard procedure for pumping oil into a storage tank and complex tasks such as managing process upsets, which would comprise the more complex task. Alternatively, it may be appropriate to have a series of assessments, with the type of assessment matched to the complexity of sub-tasks. Thus, competence in following standard procedures may be tested by observing performance on a sample of procedures, whilst emergency response competence may be assessed more systematically.

Simpler tasks

- Manual operation of a pipeline valve, such as opening it to a pre-determined level.
- Tightening a bolt to the correct torque.
- Fitting a seal to a pump.
- Follow a standard off loading procedure for a petrol tanker.

Intermediate complexity

- Follow instructions for a chemical batch process;
- Dismantle a pump;
- Set a series of hardware and software interlocks in accordance with a set of safety instructions.

Most complex

- Develop a safe system of work for cleaning out a reactor vessel;
- Determining process safety limits;
- Respond to a process upset on a refinery;
- Start-up a chemical process.

Degree of error detection / supervision

It is envisaged that a lower level of competence assessment is required for those tasks that are closely supervised or have other reliable means of error detection, and vice versa, a higher level of assessment is required for less directly supervised tasks. Some tasks are inherently "unsupervised", such as driving road tankers, whilst the level of supervision in other tasks is a matter of policy, such as the inclusion of supervisors within maintenance teams. In the case of (say) batch chemical processes there may be a high level of instrumentation provided to detect out of limits pressures and temperatures.

Higher levels of error detection may be found where:

- The work is constantly supervised or double checked on completion by another member of staff.
- Engineered instrumentation will reliably detect and annunciate errors such as setting temperatures above limits.

Lower levels of detection are found in:

- Lone working;
- Tasks that are not constantly supervised or shadowed.

It should be recognised that any claim for error detection/supervision, that is used to justify a lower level of competence assessment, would constitute a formal safety case claim and hence would be subject to inspection, i.e. the continued operation of plant would be prefixed on the availability of supervision and engineered forms of error detection.

Immediacy of effect (error tolerance)

It is envisaged that if the error can lead immediately to an unsafe condition or incident, a higher level of assessment is required. In these cases there is little "error tolerance", in that an error can have an immediate adverse effect. This may be because there is little if any time between an error and the onset of an incident. Also, if the person is the last port of call for the prevention of a major accident (i.e. most senior person on hand or the individual response for emergency shut down) then it may be necessary to increase the "pass" mark. Such tasks are sometimes referred to as "first shot tasks" in that you must get them right first time, or within a short period of time.

Examples of “first shot” tasks include:

- Cutting into a hydrocarbon pipe, i.e. if you cut into a pipe containing (say) flammable gas it will probably ignite and cause an explosion/fire;

- Removing a blank on a pipeline, i.e. if you remove a blank from a pipe containing (say) toxic liquids there will be an immediately leak;

- Commencing hot work or grinding works in a confined space;

- Shutting down a process in an emergency (wherein a delay would allow the incident to escalate);

- Driving a chemical road tanker;

- Adding the correct amount of reactive chemical to a reactor;

- Start the offloading pump for a road tanker;

- Fail to detect a faulty Pressure Relief Valve.

In these cases you would wish to ensure the person is fully competent before they take responsibility for a task.

3.5.5 Examples of competence standards and assessment criteria

It is reiterated here that competence assessment should aim to acquire performance-based evidence of competence in relation to a standard that a person can carry out a task, rather than just collate evidence of underpinning knowledge. Thus, standards should denote demonstrable skills. In addition, assessment criteria need to be defined regarding what comprises “competent” performance. This may take a number of forms, many of which are complimentary.

Examples of competence standards and assessment criteria are given below.

- Operators involved in emergency response need to successfully carry out an emergency response procedure on three separate accident scenarios selected from the safety case, on a simulator;

- Process control room supervisors may need to successfully manage a simulated emergency response in three tests (out of a possible set of 10 scenarios) and display appropriate behaviours such as task delegation and effective communication;

- Supervisors must correctly manage an operation, such as removing a hydrocarbon pump, starting from developing the plan of work, specifying a permit to work, instructing staff, monitoring their work, checking pump integrity prior to start up… etc;

- Safety engineers must be able to correctly interpret a piping and instrumentation diagram, identify all (contrived) engineering defects and specify safety devices and engineering modifications as noted in company standards;

- A maintenance technician should be able to recollect all key safety actions required in the isolation of a hydrocarbon pump, its dismantling and restoration;

- A fitter must correctly fit a seal to a pump on three separate occasions.

In each case guidelines may be set regarding the range of observable behaviours, task outcomes and skills that should be demonstrated and the criteria by which "successful" performance is judged. These may be augmented by "tests" of underpinning knowledge, such as:

- Minimum periods of "observed" experience – wherein periods of satisfactory work are taken to be indicative of competent performance;

- Qualifications and training - used as an indication of the level of underpinning knowledge;

- Verbal or written examination of a person's knowledge and/or attitudes.

Where a person is required to pass certain test to gain a qualification, this may be taken to be indicative of their possession of (a certain body of) underpinning knowledge and skills, depending on the nature of the qualification and its assessment process.

Thus, a range of criteria may be devised, each matched to the type of competence (observable skills and behaviours versus underpinning knowledge).

The competence standard may assume or require a certain level of supervision, and hence there may be a scale of competence standards for people of varying degrees of competence. This is illustrated by the Institute of Electrical Engineers competency guidelines for use with safety practitioners working on safety related Electrical, Electronic and Programmable Electronic Systems, as summarised in Box 4. These provide another useful example of the format of competency standards.

Box 4: Competency for safety-related (computer-based) system practitioners

The Institute of Electrical Engineers has issued a set of guidelines that contain competency statements and guidance on assessment procedures for use with safety practitioners working on safety related Electrical, Electronic and Programmable Electronic Systems. These guidelines provide a useful set of categories of types of competence that can be used to guide the identification of competence for other roles. In particular, the guidance identifies four types of competencies;

- Technical skills, for example hazard analyses and report writing;
- Behavioural skills; for example personal integrity, problem solving and interpersonal skills;
- Underpinning knowledge; for example, knowledge of a particular application;
- Underpinning understanding; for example, understanding the principles of safety and risk.

A set of competency standards are defined for 12 core safety functions, such as project safety assurance management and safety validation, that must be executed to develop, operate and maintain safety related Electrical, Electronic and Programmable Electronic Systems. Each function is sub-divided into sub-tasks. A description of each task is provided along with a description of the level of performance / knowledge that needs to be demonstrated by individuals to achieve each of three levels of competence (supervised practitioner, practitioner and expert).

Assessment against the latter benchmarks is achieved by individual's presenting evidence of competence. This can include examples of past work and talking through tasks during the assessment (such as talking through a logic block and transition notations).

Thus, this example exemplifies the principles of (1) ensuring all tasks are identified by the use of task analysis, (2) defining performance standards for each task and (3) agreeing what level of evidence of performance is required to "prove" competence. In this example there are three levels of competence (supervised practitioner, practitioner and expert), which is considered a useful way of acknowledging variable level of experience and matching supervision levels to the individual's competence level.

3.5.6 National standards and qualifications

It is common practice to use national qualifications as a means of demonstrating skills and knowledge. Whilst this is entirely reasonable it is important to:

- Ensure that the national qualifications cover the specific skills and knowledge required by the site's processes, equipment and activities, including specific safety matters;
- Tailor the syllabus of schemes such as NVQs to match the specific skills and knowledge required by the site's processes, equipment and activities;

- Recognise that NVQs by their nature are limited to assessment of on the job performance and hence may not cover infrequent safety critical activities, such as emergency response, process upsets, infrequent maintenance activities etc;

- NVQs by the nature of their on the job assessment do not support the selection of persons for such posts;

- Ensure that the form of assessment and level of performance evidence collated matches the safety criticality of the site's processes, equipment and activities, particularly the rigour of on the job assessment.

It is pertinent to note that in some cases national qualifications are used as evidence of underpinning knowledge and certain generic skills, but their implementation is guided by in-house assessment of the specific skills and knowledge associated with the site's processes, equipment and activities. In addition, it should be noted that some organisations have felt that their assessment process has been "NVQ driven" rather than driven by their range of activities. Accordingly, it is again important to ensure that the scope of assessment covers safety critical activities and the specific skills and knowledge needed to prevent major accidents. Finally, as NVQs are designed to cover all aspects of task performance, they may include tasks and activities that have relatively little bearing on major accident prevention. Hence, whilst NVQs may assist with the demonstration of safety related competences, major accident prevention may not by itself require completion of the entire NVQ syllabus.

Some examples of national qualifications that are commonly drawn upon as part of the process of assuring safety related competences include:

- The (Vocational Qualifications in Science Engineering and Technology (VQSET) set up by the Chemical Industries Association and the Association of British Pharmaceutical Industry, that cover process operations, process engineering maintenance, packaging operations and laboratory activities;

- The Institute for Supervision and Management S/NVQ in Team Leading and Management;

- The PINTO NVQ unit 16 in Event Management;

- Possession of NEBOSH certificates (by safety officers and senior supervisors);

- Certificates in, for example, Live Low Voltage Work;

- The Institute of Electrical Engineers competency guidelines for use with safety practitioners working on safety related Electrical, Electronic and Programmable Electronic Systems

- Possession of academic qualifications such as ONCs, HNCs and chemical engineering degrees.

3.6 SELECTING THE METHOD OF ASSESSMENT / FORM OF EVIDENCE

3.6.1 Overview

There is a wide range of assessment methods, each of which is more or less suitable for testing different types of skill and underpinning knowledge. For example;

- Observational (on the job or offline) methods and question and answer sessions are used for routine operational and maintenance skills;
- Written tests may be used to assess supervisors', managers', engineers' etc underpinning knowledge of plant, procedures and hazards;
- Simulated exercises are used to enable observation of infrequent tasks such as emergency response or infrequent operations such as managing process upsets.

The type of assessment method to be applied should take into account:

- The nature of the competencies – for example are they manual skills or do they entail a high level of decision making?
- The complexity of the task and associated competencies;
- Whether the execution of the task is observable – for example the thinking entailed in the diagnosis of a process upset cannot be directly observed whilst partial opening of a valve can be directly observed?
- Whether it is safe to assess performance on the job.

It is important to use a method of assessment that provides a valid and reliable measure of performance and underpinning knowledge. This requires that the method of assessment provides a measure of the type of competence in question and the design of the assessment process is reliable, such that two different assessors would give similar results. Ideally the reliability of the assessment process would be monitored by review of actual performance, i.e. does the standard of staff performance accord with the results of competence assessment. If sub-standard performance is observed, in contrast to acceptable assessment results, the validity and reliability of the assessment process should be reviewed.

3.6.2 Key considerations

Match of assessment method to type of competence

The assessment method needs to provide a valid and sensitive measure of the type of competence required. For example, observation of a person carrying out a procedure may demonstrate their ability to recall and follow procedures, but it may not test whether they understand the consequences of deviating from the procedure. Table 5 provides advice on the match of assessment methods to each type of competence. In summary;

- Physical / sensory-motor competences: These can be demonstrated by practical "show me" assessments wherein people either complete the real task or a component of it, such as

actually driving a road tanker to demonstrate steering skills and reading road signs to prove their visual acuity.

- Ability to carry out a prescribed procedure of work: As with physical competences, the ability to carry out a prescribed procedure of work can, usually, be demonstrated by a "show me" test wherein you attempt to complete the task.

- Cognitive skills: The ability to (say) assimilate process control information from a VDU and thereafter interpret it might be demonstrated by a verbalised walkthrough, wherein the candidate talks through the interpretation of displayed information. However, such verbalisation may interfere with some cognitive skills whilst it may not be possible to verbalise other cognitive skills, such as mental arithmetic. In these cases post task debriefing of why candidates took certain actions may be more appropriate or aptitude tests of component skills may be necessary.

- Knowledge of equipment, plant and processes: Whilst satisfactory completion of a task that requires the use of knowledge, such as fault diagnose, may be indicative of possession of underpinning knowledge, there remains an inferential jump that the correct action was not spurious. Accordingly, knowledge tends to be assessed through verbal or written questioning. The possession of formal qualifications or assessed training / work experience is often used as measures of knowledge.

- Interpersonal skills: Whilst psychometric personality tests may provide a prediction of interpersonal behaviours, observation of actual behaviour in the work setting using behavioural markers tends to provide a more valid measure.

- Team management skills: As with interpersonal skills, whilst psychometric personality tests may provide a prediction of team management skills, observation of actual behaviour in the work setting using behavioural markers tends to provide a more valid measure.

- Safety behaviours and attitudes: As with interpersonal skills, whilst psychometric tests may provide a prediction of safety attitudes and behaviours, observation of actual behaviour in the work setting using behavioural markers tends to provide a more valid measure.

Certain tasks may have very special requirements, such as detecting faults in pipelines, where the individual needs to distinguish between real cracks and false alarms using ambiguous information. Specialist advice on such assessments is required.

Table 5 Matching assessment methods to types of competence

Type of competence	Type of assessme nt methods	Examples
Physical and sensory motor skills (visual, auditory, touch, etc)	Practical "show me" tests Simulated tasks / mock ups Peer review of quality of work Evidence of prior experience	NVQ based assessment Driving skill road tests Workshop based test of welding ability on a mocked up item of equipment.
Ability to carry out a prescribed procedure of work	Simulated exercises Pen and paper tests Verbalisation talk-throughs Shadowed work Peer assessed decision making Post task debriefing – verba lisation of decisions	Classroom verbal test of candidate's recollection of a procedure of work. Talking through the correct procedure of isolating a hydrocarbon pump using a Piping and Instrumentation diagram. Observation of a fitter following the procedure for installing a seal on a hydrocarbon pump, checking operability and advising operations that its safe to restart.
Cognitive skills	Simulated exercises Pen and paper tests Verbalisation talk-throughs Peer assessed decision making Post task debriefing – verbalisation of decisions Peer observation and feedback Psychometric tests Shadowed work	Performance of a sample of tasks on a control room simulator. Talking through the interpretation of a set of alarms. Completion of SHL aptitude tests.

Type of competence	Type of assessme nt methods	Examples
Knowledge of equipment, plant and processes	Verbalisation talk-throughs Verbal knowledge tests by experts Post task debriefing – verbalisation of decisions	Verbal or written examination of individual's knowledge of safety function of various items of equipment, including formal qualifications / tests. Explanation of how a chemical reaction may go exothermic due to process deviations.
Interpersonal skills	Peer observation and feedback Group exercises Self-assessment questionnaires & psychometric tests Shadowed work	Observation of behaviour using behavioural markers in real or simulated activities. Self-completion of psychometric questionnaires.
Team management skills	Peer observation in real or simulated tasks. Self-assessment questionnaires & psychometric tests	Observation of behaviour using behavioural markers in real or simulated activities. Self-completion of psychometric questionnaires.
Safety attitudes and behaviours	Peer observation in real or simulated tasks. Verbal tests	Observation of behaviour using behavio ural markers in real or simulated activities. Statement about the appropriate way of responding to (say) conflicting operational / safety requirements. Verbal examination of supervisors understanding of how their behaviour influences safety climate.

How complex is the task?

It is expected that a more sophisticated form of assessment is required for more complex tasks. For example;

- A simple "show me" test may be sufficient to judge performance of (say) attaching a hose to a connection;

- The ability to diagnose the cause of process upsets may require completion of a series of simulated incidents, with assessment guided by a checklist of appropriate behaviours such as information acquisition, communication and evaluation of alternative causes.

There are two options when a job entails a range of tasks, of varying complexity. First, the question could be answered on the basis of what is the most complex task, i.e. are all tasks simple or are some of intermediate complexity. For example, a process operation job may entail "simple" tasks such as following a standard procedure for pumping oil into a storage tank and complex tasks such as managing process upsets, which would comprise the more complex task. Alternatively, it may be appropriate to have a series of assessments, with the type of assessment matched to the complexity of sub-tasks. Thus, competence in following standard procedures may be tested by observing performance on a sample of procedures, whilst emergency response competence may be assessed more systematically.

Is offline assessment required?

There are a number of reasons for requiring off line assessment, such as assessment on a mocked up task, including;

- If error in a real task could lead to an incident;

- If the skill or knowledge is not observable, such as a mental process or knowledge of a process;

- If the real task environment is life threatening, such as isolating an ignited leak of flammable material;

- If work is unsupervised, such as lone working, and;

- If normal day-to-day work does not provide examples of this task, such as infrequent operations like process start up and response to process upsets.

In these cases, assessment may need to be based on task simulations, verbal /written tests, exercises and so on.

3.6.3 Assessor competence

Following on from the selection of the assessment method, it is necessary to determine assessor requirements. Assessors should be competent in the process of competence assessment and have a certain level of knowledge and experience of the tasks being assessed. Experience and knowledge of the task is important for the assessor to be credible in the eyes of the assessed. The level of expertise in assessment should be matched to the form of assessment. For example, in-house coaching on how to complete assessments may be adequate for "on the job

observation" of simple operation tasks, but completion of D32/33 may be needed for (say) assessment of more complex operational tasks. But completion of D32/D33 NVQ based assessor certificates may be needed for more complex activities such as supervisory tasks, complex control room work etc. In the case of behavioural competences such as team coordination and communication assessors may need to be trained on what comprises "good performance", what are the behavioural markers and how to gauge performance against these markers.

3.7 ONGOING ASSESSMENT

Frequency

The frequency of assessment tends to depend on the likelihood of skill decay and the safety criticality of the task. More frequent assessment tends to be required for higher risk tasks and tasks wherein skills may decay sooner. All persons tend to be assessed at least annually in the form of a performance appraisal based on line management observations of performance. People involved in complex safety critical tasks, such as process managers or control room operators, may be appraised more formally every 1 to 3 years. The highest risk tasks may be assessed every six months.

Methods of reassessment

There are a number of considerations regarding what forms of reassessment to apply. These include the possibility of skill decay, the frequency with which tasks are performed and the safety criticality of the tasks. In the case of infrequent tasks, such as emergency response or response to a process upset, normal day to day work may not provide any opportunities for performance to be demonstrated. In such a case, it may be necessary to set tasks, run simulations or exercises. For example, periodic assessment of emergency managers may comprise completion of a new sample of simulation based exercises. Similarly, individuals may be tested on their knowledge of procedures and equipment using the same methods as upon appointment. Thus, the method of ongoing assessment may not differ from assessment at the time of appointment to a post.

On the other hand, day-to-day work may provide a valid indication of performance in the case of routine frequent task, such as road tanker driving. In this case ongoing assessment may be limited to on the job observation.

However, there is an additional array of sources of evidence of performance available once a person is in post. These can include:

- SHE audits: Standard SHE audits can cover the performance of safety critical tasks, specifically the level of adherence to safe working practices and individual performance;

- Incident analysis: The contribution of individual competence to an incident can be assessed as part of the incident analysis process;

- Behavioural safety observation: Many companies use behavioural observation schemes that can provide individual observations of safety related behaviour that can be used as the basis of one to one coaching and feedback.

- Peer review: On the job performance can be monitored and appraised by line managers.

The latter sources of evidence may compliment more formal forms of assessment.

3.8 RESPONDING TO SUB-STANDARD PERFORMANCE

It is clearly important to have a pre-planned response to the identification of sub-standard performance to enable the company to act purposefully on the results of competence assessment. The response to sub-standard performance tends to vary according to the purpose of the assessment, such as for recruitment versus ongoing in post assessment, and the safety criticality of the task.

In the case of selection, promotion and recruitment decisions the discovery of sub-standard performance tends not to pose a significant "policy" problem, in that people are simply not appointed to the position and /or required to undergo further training / experience. Once a person is in post, the discovery of sub-standard performance tends to pose a more difficult challenge. First, it is important to check whether the sub-standard performance arises from omissions in training, supervision or other factors such as inadequate procedures or equipment. If the sub-standard performance is attributed to the individual, there are at least three common responses, namely;

- Retraining staff;
- Increasing the level of supervision;
- Placing limits on the scope of an individual's role and responsibilities.

In the case of the most safety critical roles, it is likely that a person will be required to demonstrate competence, perhaps by undergoing re-assessment, before they are re-authorised to take on their normal duties again, especially if they normally work unsupervised or are a key decision-maker such as a process supervisor.

3.9 EXAMPLE OF COMPETENCE ASSESSMENT REQUIREMENTS

Table 6 provides a summary of the output of moving through the stages of review, as follows:

- Column A relates to the outcome of the identification of safety critical activities;
- Column B relates to the description of key competencies;
- Column C gives the level of assessment;
- Column D describes the competence standard, and;
- Column E describes the form of assessment/evidence.

A fuller description of the post is given in section 5, including the assessor's requirements.

Table 6: Example of competence assessment requirements

Post: Operations team leader				
Safety critical tasks/activities (A)	**Key safety critical competencies (B)**	**Assessment level (C)**	**Assessment criteria (D)**	**Form of assessment / evidence (E)**
Supervision of maintenance of an isolator by an Operations team leader. This is a safety critical task: individuals are working on High Voltage equipment in a process plant area; failure correctly to enact the procedure could lead to electric shock and fire. Supervisors' responsibility is to ensure that all work is carried out safely and within the operating limits and safety standards. Their main role is to plan and monitor all the work being undertaken to ensure that hazards are avoided. They	***Underpinning knowledge*** • Knowledge of hazards (e.g. knowledge of hazards associated with carrying out portable earths) • Knowledge of processes & equipment (e.g. knowledge about what equipment will be needed to switch out the circuit) • Knowledge of Operating rules and limits (e.g. knowledge about what procedures should be followed) • Knowledge of how things work (e.g. knowledge about the function of an isolator)	H	• Pass an assessment in processes, operating rules and limits, and knowledge of hazards (e.g. does the individual know how to carry out the portable earths in order to avoid hazards); • Demonstrate underpinning knowledge of electrical engineering; • Demonstrate knowledge of this site's systems, eg correctly explain an electrical circuit diagram.	• Pen and paper tests in knowledge of hazards, systems and processes and verbal examination by assessors. • Possession of HND/NVQ 3 or 4 in Electrical Engineering • 5 years experience with pertinent electrical systems

Post: Operations team leader				
Safety critical tasks/activities (A)	**Key safety critical competencies (B)**	**Assessment level (C)**	**Assessment criteria (D)**	**Form of assessment / evidence (E)**
need to ensure that individuals carrying out the work have the correct safety equipment and safety documents for the work.	***Skills*** This task requires skills, such as: • Recollect the prescribed maintenance procedure for this task and produce a safe plan of work; • Decision making (e.g. can they make the right decision on what is the best demarcation of the site); • Prioritisation and aforethought (e.g. can they ensure that individuals are all working with the correct safety documentation); • Communicating critical information (e.g. can they communicate safety instructions for the construction of the access platform).	H	• Pass the monitored field exercise demonstrating their ability to carry out Supervisory tasks. • Ability to follow safety procedures e.g. Permits for work.	• Heavily supervised field assessment of the individuals' behaviour against pre-defined behavioural & outcome markers. • Certificates in safety procedures, eg permit to work

Post: Operations team leader				
Safety critical tasks/activities (A)	**Key safety critical competencies (B)**	**Assessment level (C)**	**Assessment criteria (D)**	**Form of assessment / evidence (E)**
	Behaviours • Safety leadership (e.g. does the individual identify and act upon unsafe acts by team members); • Coaching (e.g. does the individual advise team members of potential hazards and raise their awareness of risks); • Consistency of behaviour (e.g. does the individual ensure that the procedure is followed by all team members).	H	• Pass the monitored field exercise demonstrating their ability to carry out Supervisory tasks.	• Heavily supervised field assessment of the individuals' behaviour against pre-defined behavioural & outcome markers.

4 SELF-ASSESSMENT CHECKLIST

A checklist is shown in Table 7 for hazardous installation duty holders to use in evaluating the extent to which they have a systematic process of competence assessment for tasks and activities wherein error or sub-standard performance could contribute to a major accident..

The checklist should be used in conjunction with the advice in section 3.

The checklist is intended to provide an overview of the features a "good" competence assessment process should possess, and hence help with the development and review of arrangements.

If a score is required, one point can be assigned to each "yes" and half a point to each "partial" response. The scores can be placed on a simple scale such as:

17 or more	=	Good
9 to 16	=	Average
<9	=	Poor

It is recommended that any COMAH site graded as poor should review its competence assessment arrangements, whether or not it is a Top Tier site, whilst any Top Tier COMAH site may wish to aim for a "good" score.

Table 7: Questions for probing the process of competence assessment	Yes	Partly	No
The management of competence assessment			
1. Is the assessment of competence proactively managed as part of an integrated selection, training and assessment process? For example: • Is the need for competence assessment stated within (training) policy? • Have roles, responsibilities and adequate resources been allocated to the process of competence assessment? • Is the level of training and supervision matched to the level of individual competence? • Does the management of change process address issues of competence assessment (during delayering and downsizing)? • Are the results of competence assessment recorded? • Is the system of competence assessment audited and reviewed?			
Identification of safety critical tasks for assessment			
2. Have all those activities and tasks that have the potential to contribute to a major accident been identified?			
3. Have task inventories been prepared for all those activities and tasks that have the potential to contribute to a major accident been identified?			
4. Has the task analysis been cross-referenced to a risk assessment (such as a HAZOP, What if analysis or safety review) or safety case, or has an error analysis been carried out – such that the safety criticality of tasks is validated?			
5. Has the safety case been reviewed so as to identify emergency scenarios (and process upsets/ abnormal operating states) and safety critical tasks for which staff competence needs to be assessed?			

Table 7: Questions for probing the process of competence assessment	Yes	Partly	No
Competence standards and assessment criteria			
6. Are there a set of valid and comprehensive descriptions of safety related tasks, covering operations ma intenance and abnormal events, for use in assessing a person's performance?			
7. Do the task analyses identify the necessary underpinning knowledge of equipment, processes, hazards and consequences?			
8. In the case of supervisory and managerial roles/ activities, does the task description cover specific safety tasks such as risk assessment, developing safe systems of work, effective communication, etc?			
9. In the case of tasks such as emergency response and supervision, does the task analysis cover the "softer" (non-task specific) competencies of team management, communication, event recognition, delegation and so on.			
10. Is competence assessment supported by a set of standards that cover: • A list of those tasks that staff need to be competent in; • A specification of the skills, knowledge, behaviours and correct working practices / procedures against which performance can be judged; • Guidance on what constitutes acceptable evidence of performance, such as written tests, on the job observation, simulated exercises, minimum periods of experience and qualifications; • Measurable criteria for judging adequacy of performance during assessment, such as correctly completing a task three times, or successfully managing a simulated emergency response in three tests (out of a possible set of 10 scenarios)..			
11. How have NVQs or any other national standards been adjusted to match site hazard / risk profile?			

Table 7: Questions for probing the process of competence assessment	Yes	Partly	No
12. Have the standards been "graded", as appropriate to allow for different individual levels of competence and supervision?			
13. Has the level of error tolerance (in the system) been taken into account in setting competence criteria? Such as: • Hardware or software interlocks, and automatic shut down systems; • Supervision.			
14. Has the realism of performance standards been reviewed to ensure that competence expectations reasonable and realistic?			
Assessment method			
15. Is the scope of assessment adequate? For example, does it cover, as appropriate: • Process knowledge; • Understanding of hazards associated with the process/ equipment / plant; • Understanding of correct operating procedures and practices; • Safety behaviours and attitudes; • Demonstration of correct performance, and; • Softer competencies such as safety leadership, as appropriate			
16. Is there a suitable match of assessment methods to the different types of competencies? For example: • On and offline observation of task performance for operational skills; • Simulation based assessment of process upsets and emergencies; • Behavioural observation for "soft" competencies such as safety leadership, communication and teamwork;			

Table 7: Questions for probing the process of competence assessment	Yes	Partly	No
• Question / examination based assessment of knowledge.			
17. Is on the job assessment guided by a set of standards and assessment criteria?			
18. Is on the job assessment independent?			
19. Is assessment carried out by accredited or otherwise trained trainers / assessors with pertinent process experience?			
Monitoring and updating competence			
20. Have minimum "check and train" requirements and frequencies been set for staff in post?			
21. Is the frequency of re-assessment matched to the frequency and safety criticality of tasks, with for example, annual simulator assessment of complex control room tasks and, annual on the job appraisals for routine plant operation?			
22. Is an appropriate set of assessment methods used to check ongoing competence? Such as: • Simulation / exercise based assessment for infrequent tasks; • Verbal or written tests of retention of knowledge and /or up to datedness of knowledge; • On the job observation of routine tasks.			
23. Is appropriate use being made of safety audit and other performance review systems to identify individual competence problems? For example: • Is there a system in place to report and review the cause of significant errors and refer, as necessary, people back to a "check and train" process? • Are the results of behavioural safety observation used to identify individuals behaving unsafely and providing them with coaching?			

Table 7: Questions for probing the process of competence assessment	Yes	Partly	No
• Do general SHE audits report individual competence issues?			
24. Are appropriate standards used to guide the assessment of "on the job" performance of staff in post?			
Responding to failure			
25. Does the company have a planned approach to the identification of sub-standard competence, such as retraining, demotion and / or increased supervision?			

5 COMPETENCE ASSESSMENT EXAMPLES

5.1 PROCESS PLANT MAINTENANCE FITTER

5.1.1 Identify Safety Critical Task

In this instance the task that has been identified is the disconnection of the motor, this is a safety critical task because the motor powers the emergency shutdown valves.

5.1.2 Task Description

A description of the prescribed procedure of work is given below, for use in judging individual performance:

1. Establish the state of the electrical isolation/locate the current motor isolation certificate

2. Obtain clearance certificate to disconnect motor

3. In sub-station, check if motor is isolated, with iso-lok, ops. Padlock, an isolation tag fitted, add reason for motor disconnection – fit personal padlock and prove "volt stick" voltage tester

4. At the Remote Control Unit check the motor isolation certificate, white copy details are OK, release stop button – try to start motor, if no start – re-operate stop button

5. Remove terminal box cover, test all terminals for voltage ensuring no supply present, remember – " test before you touch" – inspect terminal box and cover flange faces for damage

6. Using white metallic labels, make a sketch of connections showing, cable entry, motor rotation for non drive end (NDE), motor duty number/date, and sign two copies of the label

7. If cable cores not marked fit number tags

8. Remove gland plate or break down cable gland from motor, inspect individual core insulation, termination lugs and pillars, and general condition of terminal box

9. If possible – bolt all 3 cores to the motor earth cable, otherwise insulate individual cores, attach one label to cable and seal in plastic bag, fasten in safe location

10. Fasten second label to motor, inside terminal box if possible seal in plastic sheet

11. Return to sub-station and remove personal lock

12. Sign off clearance certificate

5.1.3 Types of Competencies

A list of the skills and underpinning knowledge needed to carry out this task are given below:

Underpinning knowledge

- Knowledge of hazards (e.g. does the individual understand the consequences of not checking the motor isolation certificate white copy details);
- Knowledge of processes and equipment (e.g. does the individual understand how to test all terminals for voltage);
- Knowledge of how things work (does the individual know how to operate their personal padlock).

Skills

- Ability to recall and correctly carry out each step of the prescribed procedure (e.g. Establish the state of electrical isolation and then locate the current motor isolation certificate);
- Technical reading skills (e.g. the ability to understand the clearance certificate);
- Physical skills (e.g. ability to remove the terminal box cover);
- Technical drawing skills (e.g. the ability to make a sketch of connections);
- Visual skills (e.g. ability to identify if cable cores have been marked or not).

Behaviours

- Awareness of safety priority (e.g. can the individual prioritise obtaining the clearance certificate over testing the voltage terminals)
- Appreciation of standards (e.g. can the individual identify the right company safety standards associated with this task)
- Consistency of behaviour (e.g. does the individual perform the task safely and in the same manner throughout their three demonstrations of the task)

5.1.4 Competence Standards and Assessment Criteria

In order to be deemed competent in carrying out this task individuals will have to pass the following:

- Pass Knowledge tests in processes, hazards and how things work (e.g. individuals should understand how to establish the state of the electrical isolation, how to fit their personal padlock and the hazards associated with not understanding these tasks);
- Pass simulated exercise, or real life demonstration in carrying out task. The task should be performed three times in order to ensure that the individual is competent in this area;
- Satisfactory rating by the supervisor on measure demonstrating that the individual displays appropriate safety behaviours towards the task (e.g. did the individual stop work if the procedure could not be followed);
- NVQ Level 2 in maintenance fitting;

- 2 years experience in maintenance fitting;

- Pass all the relevant criteria in the ongoing assessment stage.

The requirements to have a Level 2 NVQ and 2 years experience would only apply to unsupervised staff. These two requirements are taken to be indicators of underpinning knowledge and skill on the assumption that appropriate forms of on the job assessment are applied.

5.1.5 Assessment Method

Rationale for method of assessment

This task requires the individual to have knowledge of potential hazards, of processes and equipment. The assessment should therefore, contain a test of this knowledge.

Furthermore, the task requires the individual to be able to carry out the stages of the task. The assessment should involve a demonstration of all the task stages to ensure that the individual is competent in carrying them out. The task may also involve some communication skills (e.g. when obtaining the clearance certificate they may need to provide a reason for why they are disconnecting the motor) and team working skills if the task involves working in a team (e.g. can the individual cooperate with team members in order to ensure the task gets done safely).

The task also requires the individual to display relevant safety behaviours, have appreciation of safety standards and show consistently safe behaviour. The assessment will need to contain a test to ensure that the individual is performing these behaviours.

Assessor Competence

As this task entails a "simple" observational assessment against a prescribed procedure, it should be possible for a Supervisor to complete the assessment. The assessor should be familiar with the task and should have been instructed on the assessment process.

Tests of Knowledge

A test of knowledge of potential hazards, processes and of how things work could be achieved by giving individuals a pen and paper or verbal test asking them questions in this area and probing their underlying knowledge. Example test questions of knowledge could include the following:

- What are the potential hazards associated with not following the procedure?
- What should you do if cable cores are not marked?
- What should you do after returning to the substation and removing the personal lock?

The individual could be scored on criteria, for example, for the above questions they could be scored on the following:

- Can the individual name all the potential hazards associated with not following a procedure? Y/N
- Can the individual identify what they should do if the cable cores are not marked? Y/N
- After returning to the substation and removing the personal lock can individuals identify what they should do after this? Y/N

Furthermore, the possession of an NVQ level 2 could be used as a measure of knowledge of competence in Maintenance skills.

Demonstration of Skilled Performance

These skills could be tested by a simulated mock up of the task using dummy instrumentation; this would ensure that the individual is carrying out the task using all the appropriate skills. Furthermore, use of a simulated mock up will allow individuals to make errors without them leading to hazards. Individuals could be rated on the following criteria:

- Did the individual follow the procedure for carrying out the task? Y/N
- Did the individual fit the number tags correctly if the cable cores were not marked? Y/N
- Did the individual sign off the clearance certificate? Y/N
- Did the individual explain the reason for disconnecting the motor effectively in order to obtain a clearance certificate? Y/N

If a simulated mock up is not possible then individuals could do a supervised real task to ensure that they can demonstrate the task competently.

Demonstration of Safety Behaviours

Furthermore, the individual will need to be able to demonstrate that they can display appropriate safety behaviours and demonstrate consistent behaviours towards the task. Supervisors in this area could monitor the individual in their performance. There could be standard criteria that the individual is marked against, for example:

- Does the individual stop work if the procedure cannot be followed? Y/N
- Does the individual test whether there is no voltage supply present before touching? Y/N

5.1.6 Ongoing assessment

As this task is frequently performed then reassessment can take place every year as part of an on the job assessment. The assessment could take the form of an observational assessment where the individual is observed performing the task by their line supervisor.

5.2 EMERGENCY RESPONSE MANAGER

5.2.1 Identify safety critical task

An emergency scenario could be identified from the COMAH safety report, for this example the scenario is the leak of hydrocarbon from a storage tank. This is a safety critical task because the leak from the hydrocarbon tank has the potential to cause a major fire.

5.2.2 Task Description

A task description is given below. In the present scenario Supervisors need to:

- Predict how the event will escalate;
- Identify what equipment to switch off – to avoid igniting the leak;
- Identify the location of the leak;
- Correctly diagnose leak and use the correct response, such as evacuate area, isolate tank, shutdown any nearby sources of ignition and apply foam;
- Correctly delegate responsibilities e.g. who turns on the emergency pumps;
- Call in the emergency services;
- Coordinate emergency response staff;
- Decide if an evaluation is needed.

5.2.3 Types of competencies

This task will require the Supervisor to have underpinning knowledge and skill in the following areas.

Knowledge

- Knowledge of hazards (e.g. knowledge of how the event can happen and how it may escalate);
- Knowledge of processes and equipment (e.g. knowledge of how equipment may have been damaged and how this may affect how the event escalates);
- Operating rules and limits (e.g. what procedures should be followed in the event of this accident happening).

Skills

The job of emergency response co-ordination requires individuals to have a high degree of decision-making ability under uncertainty. They will further need to assimilate large amounts of information, prioritise the information that they are given and weigh up different scenarios for handling the events.

Individuals have to have appropriate interpersonal skills in order to get the best performance from their team. They have to be able to communicate and direct their team in the best strategy for resolving the event and therefore need to have clarity of language, listening skills and command skills. Furthermore they have to be able to appropriately delegate work amongst their team. Examples of skills are given below:

- Information acquisition and assimilation (e.g. as the event escalates does the individual demonstrate the ability to come to a timely decision about emergency response actions);

- Decision-making; comparing options, balancing conflicting information, handling uncertainty (e.g. can the individual demonstrate the ability to balance conflicting information and make decisions under uncertainty);
- Prioritisation and aforethought (e.g. can the individual prioritise the most important control actions);
- Error detection (e.g. can the individual detect colleagues' errors that exacerbate the incident, such as failing to switch off pumps feeding the tank);
- Active listening (e.g. does the Supervisor listen attentively to colleagues to ensure he or she has all the necessary information to be able to make informed decisions);
- Communicating safety critical information (e.g. does the individual ensure that all the necessary safety critical information is communicated effectively);
- Soliciting information (e.g. does the individual gather all the necessary information to deal with the event effectively);
- Work distribution and delegation (e.g. can the individual delegate responsibility for certain tasks to others to avoid task overload);
- Co-ordination (e.g. can the individual structure the response to the emergency in order to ensure that the best outcome is achieved).

Behaviour

- Awareness of safety priority (e.g. does the individual prioritise isolating the leak as opposed to, say, handling media calls);
- Ability to control stress levels (e.g. does the individual remain calm and composed throughout).

5.2.4 Competence standards

Supervisors would be expected to achieve the following:

- Successful completion of a verbal or written knowledge assessment covering knowledge of hazards, operating rules and limits, processes and how things work (e.g. Supervisors will need to understand how the leak from the hydrocarbon tank will affect other buildings and equipment and the hazards associated with this);
- Successful completion of a simulated exercise assessing the individuals skills to carry out emergency response management;
- Satisfactory ratings on Psychometric tests;
- NVQ Level 3 in the PINTO NVQ standards;
- 5 years experience in a Process Operation role.

Psychometric test may be used to appraise whether the individual's personality and behavioural traits predispose the individual to the role of team management and decision –making. However, as psychometric tests assess traits they only provide an indirect indication of potential performance. Accordingly, performance in a simulation should be used as the primary form of assessment.

The NVQs and minimum periods of operating experience may be used as indicators of underpinning knowledge and skill, assuming they are appraised whilst on the job.

5.2.5 Assessment Method

Rationale for method of assessment

The job of emergency response requires individuals to have process specific knowledge in order to effectively diagnose event situations effectively. There should therefore be some sort of test of process specific knowledge, in order to ensure that the individual has a good understanding of the possible event scenarios that could occur on their site.

The assessment should also include a demonstration of the main skills that the individual will use when managing an event. As has been stated this scenario will require the individual to use decision-making and problem solving skills, furthermore, the individual will have to use interpersonal skills and team management skills. The task of emergency management also requires the individual to demonstrate safe attitudes and behaviours to their work; the assessment should also include this.

Given that there are few if any occasions in normal operations for individuals to demonstrate their emergency response skills, assessment would rely on simulated exercises of the possible scenarios that Supervisors will face. Moreover, given the risk posed by real emergencies it is essential to appraise an individual's emergency response competence before they are assigned to such a role. Finally, as the skills needed to handle emergencies can differ to those used in normal operations, it is unlikely that competence can be assessed on the basis of "on the job observation". The skills and behaviours that individuals demonstrate on a day-to-day basis may not be a reliable index of how they will behave in actual events.

These scenarios should be based on a sample of events that are likely to occur on the individuals' site and will likely be related to the COMAH safety case report. The simulation would need to include coordinating people and handling information, in order to test the full range of decision-making and team management competencies.

Fully understanding how individuals will react under real event situations is difficult to assess during simulations, however there are ways of making simulations as near to real events. For example, central control rooms can be replicated. Furthermore, scenarios can be created where individuals have to respond to events, as they would normally be expected to occur in the individuals working environment.

If a simulation of a real event is not possible, then individuals could be asked to take part in a desktop or workplace exercise, where a scenario is given to them and they are asked to describe their responses to particular events.

Assessor Competence

In this case the task being assessed and the range of competences involved are diverse and relatively complicated. Therefore, a relatively high standard of assessor competence is required. Assessors should have:

- An appropriate level of experience in process operations;
- They should have gained the NVQ level 3 or above in the area of event management,
- Instruction on the use of observational techniques for team management and decision making skills, and;
- An assessor's qualification (e.g. NVQ D32/D33) that gives them the ability and qualifications to train others in event management.

Tests of knowledge

Individuals could be assessed on their knowledge of the process by pen and paper tests, verbalisation talk- throughs or by verbal knowledge tests. Examples of questions could include:

- How may this event happen and how may it escalate?
- In the event of an accident what are the main operating rules and standards that should be followed?
- What effect would the leak have on the normal plant equipment?

The criteria for successful performance in these questions could be the following:

- Can the individual state how the event may happen and how it may escalate? Y/N
- Can the individual name the operating rules and standards that should be followed in the event of a fire? Y/N
- Can the individual name the effects on the equipment that will be caused by the leak? Y/N

Demonstration of Skills

When the simulator is used, individuals should be measured against appropriate criteria of performance that look at the their ability to make decisions, communicate effectively and manage their team. These could also include "outcome" indicators such as time taken to identify the leak. Examples of this could include:

- Was the leak identified and isolated in a timely manner? Y/N
- Were emergency response teams alerted in a timely manner? Y/N
- Did the individual make safety decisions that were appropriate to the chosen event scenario
- (for example did they switch of nearby electrical equipment, switch off pumps supplying the tank etc)? Y/N
- Did the individual communicate effectively to the team (i.e. did they communicate all the instructions that were necessary for the task, did they clearly state their instructions in an unambiguous manner)? Y/N
- Did the individual manage their team effectively (this will include issues of effectively delegating tasks to team members, controlling team dynamics and achieving a common purpose)? Y/N

The assessment could also use Psychometric tests in order to assess whether the individual has the appropriate traits for decision-making and team management. Examples of Psychometric

tests include the Myers-Briggs Type Indicator and the Thomas Human Resources Management System.

Demonstration of Safety Behaviours

In this emergency individuals will also have to demonstrate that they can display appropriate safety related behaviours. This could be assessed by observation during the simulation/ exercise, using a set of behavioural markers. Examples of the criteria they could be assessed on are as follows:

- How would you rate the individuals' ability to ensure that emergency response staff did not place themselves at unnecessary risk?

Excellent	Very Good	Good	Adequate	Poor
5	4	3	2	1

- How would you rate the individuals' ability to balance the need to safeguard staff whilst minimising plant damage?

Excellent	Very Good	Good	Adequate	Poor
5	4	3	2	1

5.2.6 Ongoing assessment

Individuals could be assessed on one major accident scenario every year in order to assess for competence in event management, using the same simulator / exercise method but different scenarios.

5.3 OPERATIONS TEAM LEADER

5.3.1 Identify a safety critical task

In this instance the task is the supervision of the maintenance of an isolator by an Operations team leader. This is a safety critical task as individuals are working on High Voltage equipment in a process plant area; failure to correctly enact the procedure could lead to electric shock and fire.

5.3.2 Task Description

The supervisors' responsibility in this task is to ensure that all work is carried out safely and within the operating limits and safety standards set out by the company. They need to ensure that individuals carrying out the work have the correct safety equipment and safety documents for the work. Their main role would be to plan and monitor all the work being undertaken to ensure that hazards are avoided. A description of the task is provided:

1. Planning of the task

2. Work package is given to the supervisor for review, they need to ensure the correct systems of safety and materials are in place for the work

3. Authorised person then switches out the circuit

4. Supervisor would do portable earths and ensure that they have the right safety documentation to carry out the task; they would also define demarcation for the task

5. Documents to carry out the task are then issued to a competent person

6. Competent person then briefs the working party

7. The work is then carried out from an access platform

8. Once work is completed, competent person then withdraws working team, and clears the safety document

9. The system is then returned to service

5.3.3 Types of Competencies

The types of underpinning knowledge and skills involved in this task are as follows:

Underpinning knowledge

- Knowledge of hazards (e.g. knowledge of hazards associated with carrying out portable earths)

- Knowledge of processes and equipment (e.g. knowledge about what equipment will be needed to switch out the circuit)

- Knowledge of Operating rules and limits (e.g. knowledge about what procedures should be followed in the present task)

- Knowledge of how things work (e.g. knowledge about the function of an isolator)

Skills

This task requires a combination of decision-making, communication and team management skills, such as:

- Recollect the prescribed maintenance procedure for this task and produce a safe plan of work;

- Decision making (e.g. ability to decide between options for carrying out the task and deciding on the best option i.e. can they make the right decision on what is the best demarcation of the site);

- Prioritisation and aforethought (e.g. can they prioritise the most important aspects of the task first i.e. can they ensure that individuals are all working with the correct safety documentation);

- Communicating safety critical information (e.g. can they communicate areas of the work package that may be potentially hazardous such as providing safety instructions for the construction of the access platform);

- Work distribution and delegation (e.g. Does the individual ensure that the Authorised person is the individual that switches out the circuit);

- Dexterity (e.g. does the individual have enough dexterity in order to assist in the construction of access platforms);

- Physical strength (e.g. does the individual have enough physical strength in order to help with the construction of access platforms);

- Identifying individual commitment (e.g. does the individual identify the key abilities of team members, i.e. do they ensure the individuals with the right abilities are carrying out tasks);

- Recognising the need for other specialist skills (e.g. does the individual monitor their own abilities and call for assistance if they need more specialist knowledge).

Behaviours

- Safety leadership (e.g. does the individual identify and act upon unsafe acts by team members);

- Coaching (e.g. does the individual advise team members of potential hazards and raise their awareness of risks);

- Consistency of behaviour (e.g. does the individual ensure that the procedure is followed by all team members).

5.3.4 Competence Standards and Criteria

Individuals will be expected to meet the following standards in order to be deemed as competent in this task:

- Pass the knowledge assessment in processes, operating rules and limits, and knowledge of hazards (e.g. does the individual know how to carry out the portable earths in order to avoid hazards and do they know the company procedure for the task they are carrying out);
- Pass the simulated exercise demonstrating their ability to carry out Supervisory tasks;
- Satisfactory ratings on the Psychometric tests;
- HND /NVQ 3 or 4 in Electrical Engineering;
- 5 years experience as an Operator;
- Individuals should have completed an appropriate number of certificates to work in this area e.g. Permits for work;
- Satisfactory completion of ongoing assessment.

5.3.5 Assessment Method

Rationale for method of assessment

The job of supervising a team in the maintenance of an isolator involves having knowledge of hazards, processes, operating rules and limits, and equipment. The assessment should therefore contain an assessment of knowledge in these areas.

The job also requires the individual to have a wide variety of skills (see above). These range from decision making skills and problem solving skills, to basic physical skills (e.g. they may need to help with the construction of access platforms). There will have to be a form of assessment that provides evidence of these skills, i.e. a practical demonstration.

The individual has to display the correct supervisory safety behaviours and has to have a general awareness of safety issues and of safety standards. The assessment should include assessment of their safety leadership abilities.

In the case of people applying for a supervisors post, the assessment will involve a simulation or heavily supervised field assessment of the individuals' behaviour, in order to assess that they have the right skills in order to carry out the work. In the case of ongoing assessment, observation of their work "on the job" would suffice.

Assessor Competence

In this case the assessor needs a relatively high level of competence to judge supervisory skills and technical knowledge. For example, they would have;

- Reached the level of supervisor or above;
- Experience in setting people to work and monitoring safety on site,
- An HND in Electrical Engineering or an NVQ level 3 or above, and;
- Instruction on the criteria and question sets to apply during assessment.

Tests of Knowledge

Individuals could be asked to complete pen and paper tests in knowledge of hazards and processes, alternatively they could also be asked to talk through verbally their knowledge in these areas or complete verbal knowledge tests given to them by experts. These methods of assessment will explore the underlying knowledge that the individual has in these areas and will allow assessors to make a judgement on their suitability for carrying out the task. Examples of questions could be the following:

- What are the hazards associated with carrying out portable earths?

- What equipment will be needed to switch out the circuit?

- What procedures should be followed in the present task?

Relevant pass/fail criteria for these questions could be the following:

- Did the individual name all the relevant safety hazards that would be associated with portable earths? Y/N
- Did the individual name all the necessary equipment that would be used for switching out the circuit? Y/N
- Did the individual demonstrate that they understood all the relevant procedures that they have to follow when carrying out this task? Y/N

Demonstration of Skills

In order to assess skills a simulation of the task could be carried out in a substation that is mechanically operable, without live high voltages. If this were not possible the alternative would be to have a closely supervised individual carrying out a live piece of work in the field.

Two independent assessors (e.g. from an independent training organisation or a Line Manager from a different site) could carry out the simulated assessment; this will provide objective assessment of the individual's performance. Criteria for passing could be the following:

- Did the individual ensure that all individuals were performing tasks safely? Y/N
- Did the individual prioritise getting the right safety documentation before starting the task? Y/N

- Did the individual ensure that the correct procedure was followed for carrying out the portable earths? Y/N

The task also requires the individual to use interpersonal skills and team management skills to carry out the task. This requires the individual to communicate clearly their instructions to a team and to effectively supervise the task so that each member has been delegated the correct roles. The individual will also have to use influencing skills and co-ordinate the team effectively. Psychometric tests could be used to assess individual's predisposition towards team management, using tests such as the Myers-Briggs Type Indicator and the Thomas Human Resources Management System. Criteria for the assessment during the simulated or field-based assessment could include:

- How well did the individual communicate instructions on the demarcation of the site?

Excellent	Very Good	Good	Adequate	Poor
5	4	3	2	1

- How well did the individual communicate safe working practices in the use of the access platforms?

Excellent	Very Good	Good	Adequate	Poor
5	4	3	2	1

Demonstration of Safety Behaviours

Furthermore, the task involves the individual being able to display the correct attitudes and behaviour towards the task they are carrying out. The assessment could consist of observation of their performance in the simulated exercise. Observers could be asked to rate individuals on criteria, for example:

- Did the individual stop any staff who were not working safely? Y/N
- Did the individual provide effective coaching about unsafe behaviours? Y/N

5.3.6 Ongoing assessment

This task is performed frequently and therefore an assessment could be based on line managers review of on the job performance, using appropriate appraisal criteria, i.e. those applied during the simulation. The appraisal should be carried out every year at the annual review. At the time of annual review the individual could also be asked to complete a verbal or pen and paper test.

5.4 FIELD OPERATOR

5.4.1 Identification of safety critical tasks for assessment

The present task involves filling a metal component with explosive and pressing it, this is a safety critical task because the individual is working with explosives, and incorrect use could lead to an explosion.

5.4.2 Task Description

A description of the prescribed procedure of work is given below, for use in judging individual performance:

1. Component comes to the individual as an approved item

2. Individual mounts the component in the pressing tool

3. Individual has explosives available

4. The individual then volumetrically dispenses explosive into the component

5. Locate component in pressing fixture and then into the press

6. Operate the press

7. Remove the pressing fixture from the press

8. Remove filled component from the fixture

9. Remove excess explosive

10. Component is then moved onto next station

5.4.3 Types of competencies

Examples of skills and underpinning knowledge are given below:

Underpinning knowledge

- Knowledge of risk (e.g. knowledge of the risks associated with working with explosive);
- Processes and equipment (e.g. knowledge of volumetric equipment and pressing fixture);
- Operating rules and limits (e.g. knowledge of the safety standards associated with the task).

Skills

- Visual Skills (e.g. the ability to identify the component, ability to identify the correct explosive material);
- Physical skills (e.g. the ability to locate the component in the pressing fixture);
- Memory Skills (e.g. the ability to recollect the correct procedure).

Behaviour

- Awareness of safety priority (e.g. does the individual work at an appropriate pace?)
- Risk awareness (e.g. does the individual demonstrate awareness of the hazards associated with working with explosives?)
- Consistency of behaviour (e.g. does the individual perform the task in the same way each time they carry it out?).

5.4.4 Competence Standards and Assessment Criteria

In order to be competent in carrying out this task the individual has to show that they can achieve the following:

- Demonstrate awareness of risk, procedures, processes, equipment and operating rules and limits (e.g. the individual needs to understand how to volumetrically measure the explosive and the risks associated with this)

- Satisfactory completion of ongoing assessment;

- Individuals should be assessed carrying out the task three times to ensure competence.

5.4.5 Assessment method

Rationale for method of assessment

As this is a highly proceduralised and relatively simple task, the main form of assessment should be a demonstration of the correct completion of the task sequence. The tasks requires the individual to have limited skills in the area of information acquisition (e.g. they need to be able to understand information on problems associated with the task), and physical skills; they need to be able to have the dexterity to carry out the task, be able to coordinate movements, and be able to sense and distinguish between different types of materials. Therefore, the assessment should include a physical demonstration of completing the task.

The assessment should also an assessment of underpinning knowledge. Given the limited extent of knowledge needed, this could take the form of a short pen and paper test, or post task verbal examination.

Assessor Competence

As this task involves compliance with a procedure the assessor should be someone who is familiar with task and has an understanding of how to complete the task safely. The assessor will have been instructed in the assessment process.

Tests of knowledge

In order to test the individual's knowledge of the processes and equipment and operating rules and limits, they could complete a pen and paper tests or take part in a verbalisation talk-through of how they would use particular equipment. Questions could include:

- What are the risks associated with working with explosive?
- What volumetric equipment would you use?
- What are the relevant safety standards associated with the task?

The criteria for passing these questions could be the following:

- Did the individual correctly state the risks associated with working with explosives? Y/N
- Did the individual correctly state what volumetric equipment they would use? Y/N
- Can the individual correctly state the safety standards that should be followed in relation to this task? Y/N

Demonstration of skills

The physical demonstration of skills could entail use of a mock up of the task in which individuals work with neutral materials and similar (or identical, if possible) equipment to the ones used in a real life setting. This will enable individuals to be assessed on their dexterity for carrying out the skill and their ability to coordinate the task. A mock up will allow the individual to freely make errors without any hazards.

It may not be possible to have a simulated mock-up of this particular task, therefore they could do carefully supervised (by supervisors that have experience in the field) online 'show me tests' after the task has been demonstrated to them.

Individuals should be measured against clear criteria, for example:

- Did the individual manage to mount the component in the pressing tool? Y/N
- Did they have the explosives easily available? Y/N
- Did the individual correctly dispense explosive into the component? Y/N

Demonstration of safety behaviours

In order to ensure that the individual displays the correct attitudes and behaviours towards the task there could be ongoing performance monitoring or observation of the individual carrying out their work by their direct supervisor. Examples of the criteria that individuals could be assessed on are stated below:

- Does the individual halt work if the correct equipment is not available? Y/N
- Does the individual report unsafe working conditions to their supervisor? Y/N

5.4.6 Ongoing assessment

This task is performed frequently and their Line Manager should assess individuals on the basis of on the job observation, using the same criteria as applied during appointment to the post. The assessment should be based on observation of normal work, i.e. were they adhering to the correct procedure.

6 CONCLUSIONS

Organisations operating high-hazard plant recognise that safety is predicated upon the experience, commitment and competence of their staff. The COMAH regulations and the lessons learnt from major incident indicate that it is not enough to assume that exposure to training and experience assures competence. There are already examples of good practice in the development and application of competence standards and systematic assessment methods. This report provides a summary of these practices in a sufficiently general way that the diverse range of sites regulated under COMAH can apply.

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APPENDIX A CASE STUDY SUMMARIES

INTRODUCTION

A:1.1 Aims

This report summarises the findings from the completion of ten case studies. The case studies had a number of aims, including:

- Development of practical examples of good practice;
- Development of an overview of how the process of assuring competence operates in practice;
- Confirmation of what comprises good practice.
- Acquisition of feedback on the design of the competence assessment guidance, and;
- Development of examples of the application the competence assessment guidance.

A:1.2 Method

Step 1: Identifying and screening a sample of firms to acquire a sample of safety related roles.

A sample of ten firms were identified that provided:

- A range of safety critical tasks;
- A range of industries;
- A range of competence assessment methods;
- Companies considered to be using good practice.

The industries covered were:

- Water utilities – emergency management roles;
- Commercial airlines – including aircraft pilot licensing;
- Nuclear sector – including roles of Duly Authorised Persons and Suitably Qualified and Experienced Personnel (SQEPs);
- Offshore oil and gas platform Offshore Installation Managers;
- On and offshore hazardous industry - shift team leaders, operations/maintenance managers, fitters, operators and tanker drivers.

Step 2: Site visits

For each selected case we would seek information on:

- How are competence needs identified?

- How are competence standards set and defined?
- What (off line and on the job) methods are used to check a person is competent, including NVQs?
- Examples of rules-of-thumb used for defining “suitable on the job experience”
- How does competence assessment interface with selection for additional skills training?
- How is competence assessment and verification recorded? Is the same method used for on the job training and competence assurance?
- What is the role of formal qualification and assessment?
- How is the standard and method of assessment and competence verification linked to the safety criticality and complexity of the task?
- Who verifies that the standards used by the verifiers and assessors are consistent and adequate?
- What are the managerial and organisational culture issues affecting validation?
- What is the process of ongoing assessment and competence maintenance?
- How is the need to revise the competence assurance process identified?
- Evidence regarding the validity of the process.

Cases completed

Case study	Type of Company	Type of tasks reviewed
A	Nuclear Power Plant Operator	SQEP process
B	Refinery	Maintenance staff and Operators
C	Batch Chemical Manufacturer	Competence of Process Technicians
D	Explosives Manufacturer	Competence of shop floor staff
E	Aircraft Operator	Competence of Pilots
F	Water Utility	Competence for Event Management and Operations
G	Offshore Staff Training Centre	Offshore Installation Managers
H	Pharmaceutical Manufacturer	Competence of Operational staff
I	Power Supply	SAP process
J	Chemicals Manufacturer	Competence of Operational staff

A.2 CASE STUDY A: NUCLEAR POWER PLANT OPERATOR

Background

The company operates in 15 countries around the world and employs more than 23,000 people. For the present case study a branch of the company was interviewed, this company was formed after the restructuring of two other companies.

Initial selection and training

The initial selection period involves individuals being judged against a set of predefined criteria that are required for carrying out that job. For all roles there are clear definitions for the following:

- Post title
- Grade of post
- Purpose of post
- Organisation
- Duties and performance criteria
- Underpinning knowledge
- Non-technical competencies
- Training
- Medical Status

If individuals meet the criteria specified they are then trained for that role in all the relevant tasks. For every job, task expert panels were used in order to state all the key tasks that were important for carrying out roles. There are training plans for every job and they have detailed information in the following:

- Guidance on the use of training specifications
- Training specifications for essential and statutory on the job training modules
- Essential and statutory on the job training modules
- Training specifications for recommended and development training
- Recommended on the job training modules

Trainees can be assessed using a number of methods:

- Verbal test
- Written test
- Simulations
- Live exercise
- Role play exercises
- Walking the system and identifying key components

Competence assurance and maintenance

Once individuals have been selected and trained they are then into the competence maintenance process. This involves them being trained to Suitably Qualified and Experienced Persons status (SQEP). A SQEP is an individual who has the right level of training and experience to carry out and supervise tasks that may have a bearing on safety. When individuals enter this process their supervisor should identify the appropriate amount of supervision that will be required. Supervision should vary in terms of the competence the staff member already has e.g. a person with limited experience would have a high amount of supervision and a more experienced

individual would have a lower amount of supervision. The level of supervision also depends on the safety criticality of the task. If individuals are inexperienced in safety critical tasks then Location Managers need to be consulted and an appropriate level of supervision should be agreed.

Training plans should be agreed for individuals working towards SQEP. This involves identifying all the tasks that the individuals will perform and training them to perform these tasks, to SQEP level, in a similar manner to the process that was involved in selection.

SQEP assessment

It is a requirement of all assessors to have SQEP status, individuals can be assessed on one occasion or more than one occasion. If assessment is required more than once then the level of supervision required for that individual should be reviewed. The SQEP assessment should cover the following areas:

- Performance of the task (or where agreed, the individual may supply diverse evidence that satisfies the performance criteria)
- Any underpinning knowledge and plant specific/safety topics
- The range of the duties role or task

The assessment methods could be one or more of the following:

- Verbal test
- Written test
- Simulations
- Live exercise
- Role play exercise
- Walking the system and identifying key components

There may be some tasks that cannot be performed due to operational difficulties in such cases assessors can ask controlled questions to assess the Operators' understanding. Individuals could also be asked to talk the assessor through particular tasks that they may carry out as a SQEP.

The decision to assess someone as a competent SQEP is based on the evidence that is gathered during assessment. Individuals are assessed as 'competent' or 'not yet competent' to carry out tasks. All decisions are given to the training department for recording on their training database. All decisions are recorded on SQEP assessment forms. If the individual is assessed as 'not yet competent' then the level of supervision given to that individual will have to be reviewed. Individuals can be given an action plan that will prepare them for reassessment.

Individuals have an annual review process that can identify the need for reassessment for SQEP status. Training plans for particular jobs can also state reassessment frequency for particular tasks. The timing of the reassessment is based on how complex the task is and how frequently the task is preformed. The same assessment process for the initial assessment is used in the reassessment.

Individuals can have their SQEP status suspended or revoked if reassessment shows them to be incompetent. If training in particular tasks lapses then individuals can have their SQEP status suspended for that task until training shows them to be competent.

ASQEP

If tasks are safety critical in nature then individuals can be trained to be an appointed SQEP (ASQEP). This is one grade above the SQEP. In this instance an appropriate level of training and experience to carry out tasks will be specified. The main duties of the ASQEP are as follows:

- Ensure work is undertaken by SQEP status individuals
- Ensure that SQEP that they are supervising are assessed for competence when necessary
- Work follows all necessary guidelines and procedures
- Ensure that SQEPs are fully briefed on the work they are carrying out
- Ensure that any problems are brought to the attention of the appropriate individuals
- All work is reviewed for any errors

Conclusions

The company has a system of competence assurance and maintenance. Individuals are assessed for SQEP level status on the tasks that they carry out in order to ensure competence to carry out jobs safely. If a job is considered high hazard then a SQEP is appointed to oversee activities (ASQEP).

Key learning areas

- Task inventories are used, with underpinning knowledge laid out
- A battery of assessment methods are used
- The whole process is managed and governed by a set of “competence standards”

A.3 CASE STUDY B: REFINERY

A.3.1 Background

The refinery, part of a worldwide organisation, has been subject to extensive expansion and updates to produce a range of oil products, fuels, and feedstock for the lubricants and chemical businesses. A positive safety culture has enabled the site to regularly reach 2-3 million man-hours (employees & contractors) without a lost time injury.

The company has a formal NVQ qualification programme for new process operators and maintenance technicians. New employees and contractors attend a safety induction programme that includes assessment. Competences, training and assessment methods are also defined for specific HSE critical activities e.g. plant inspection, work on electrical equipment, permit to work authorisation.

For Process Operators/Technicians, the company presently operates a "Procedural Competence Development Methodology" (PCDM). The system was developed in 1996 following a review of near miss reports and incident investigations for potentially hazardous incidents. The review of these incidents identified common root causes associated with procedures. A survey of all Operators indicated some generic problems with the operating procedures including:

- The procedures did not always reflect the way operators carried out the task
- Competence levels were not defined for all the procedure/tasks
- The consequence of carrying out the task incorrectly had not been documented
- The link of HSE critical procedures to hazardous scenarios in the safety report was not documented

The company developed a methodology to help prioritise HSE critical tasks and to standardise the procedural methods of performing the task and task assessment. The stages of this methodology are detailed as follows.

A.3.2 Introduction to procedural competence development methodology

There are two phases to this methodology:

- Phase 1: Developing Reference Task Analysis
- Phase 2: Developing Job Aids, Training and Competence Assessment Specifications

A: 3.2.1 Developing Reference Task Analysis

There are five steps in producing the Reference Task Analysis:

Develop Task Inventory

This stage involves a review of the tasks that the operators perform in a given work area so that the critical tasks can be identified and prioritised. Tasks are prioritised by the risks associated with the work area, analysing the consequences if the task is carried out incorrectly. Past operator experience of performing tasks correctly is also used in prioritisation. The task inventory is drawn up of tasks in this work area. The task inventory is a high level description of what is done. The aim is to identify all the areas that require operator intervention, as these are points at which hazards are controlled by procedures.

Document Current Practice

The individuals who work in a given task area are then approached and asked to describe how they carry out the tasks. These descriptions are put into Hierarchical Task Analysis (HTA) format. The level of detail in the task descriptions should be sufficient to identify all the possible consequences of error and any significant hazards in performing the task.

Identify Hazards

At this stage a criticality analysis is carried out on the HTA, to identify all the potential hazards associated with carrying out the tasks, and the possible consequences if the tasks are not carried out effectively. This process involves the technical experts and operators in the review process to ensure that all hazards have been considered and to identify where the proposed method does not ensure safety.

Agree Best Practice

Practitioners provide the information on current working practice to develop the HTA. There may be areas of disagreement on how particular tasks are best carried out; at this stage individuals are involved in discussing and agreeing a standardised method for carrying out the tasks. If there are still any differences of opinion then a compromise is reached for those tasks where variations do not have an impact on the potential consequences or error, these can be amended later on the basis of experience.

Develop Reference Task Analysis

The resulting HTA and criticality analysis form the basis of the documented standard method. These are maintained as the Reference Task Analysis.

A: 3.2.2 Developing Job Aids, Training and Competence Assessment Specifications

Job Aids and Procedural Support

The level of procedural support/job aid is determined by the criticality analysis taking into account the frequency and complexity of the task. This extends the capability of the operator to do the job e.g. by over coming memory limitations.

A.3.3.3 Competence Assessment for carrying out PCDM tasks

The inventory of tasks from the PCDM system are organised into a Work Area Training plan (WATP). The WATP contains all the tasks the operator has to learn in order to demonstrate competence to operate the work area.

A D32/33 NVQ qualified assessor, normally the Shift Manager, formally assesses each module of the WATP. Operators are not deemed competent to take over the work area until they attain the required standards.

The required standards are produced by the PCDM system that identifies the best practice procedures for carrying out the tasks; these are then used as the criteria to check that the individual is competent to carry out the tasks. If the task has not been put through the PCDM process then the assessor will use the relevant NVQ criteria for assessment.

Linking of COMAH to PCDM and competence assessment

The WATP contains all the tasks the operator has to learn in order to be deemed competent to carry out tasks. The WATP also includes COMAH and emergency response tasks. Therefore the PCDM system allows there to be a direct link between competence for general tasks and COMAH related tasks.

A.3.3 Competence systems for maintenance staff

Trainees are selected between the ages of 16-21 with 'C' or above GCSE in Maths, English and a Science related subject. Candidates then sit a Saville and Holdsworth (SHL) technical test battery covering the following areas:

- Verbal comprehension
- Numerical computation
- Visual estimation
- Mechanical comprehension
- Technical understanding
- Numerical reasoning
- Fault diagnosis
- Spatial recognition

Those who meet the required standard are then given a further calculator-aided maths test and a simple dexterity test. The final stage of selection is a structured interview assessing competence in the following areas:

- Communication
- Energy and Drive
- Initiative
- Planning and Organising
- Manner and Presentation
- Dependability
- Scientific Interest

After this process candidates are scored A to E, A being the highest. Grade C or above is considered the grade acceptable for training sponsorship.

A third party provider carries out the training for the first two years where the students undergo broad based training in Mechanical engineering, Instrumentation, Electrical, and Process. The output of this stage of training will be an NVQ level II in broad based engineering and an NVQ level II in process engineering. The students will also achieve an ONC in Engineering Science. All assessments carried out during this part of the training scheme will be by qualified assessors (D32/33). The NVQ programme used will be the recognised standard for the Oil/Chemical industry.

The final 18 months of the training will be carried out on site at the company location. At this phase of the training the students are streamed to match the estimated business need at the end of the training period. They are then assigned to the work area/ specialist skill where the estimated vacancy will exist. They are then trained on the job and by training centre courses in their specialist area (Mechanical Engineering, Instrumentation, Electrical, and Process). They will follow the relevant industry approved NVQ level III programme for their discipline. Trainee operating technicians will follow the PCDM Work Area Training Plan for the area they have been assigned to. A full NVQ scheme is in place on site for this activity comprising of on

the job assessors, internal verifiers and scheme coordinators. Those who are academically capable will be allowed to pursue a HNC in their discipline if they wish but this is voluntary.

During each phase of the training scheme an element of personal development will be introduced to help foster team working, communication, presentation skills and other soft skills. A final selection interview will take place before permanent contracts are offered.

A.3.4 Maintaining competence for maintenance staff

A central competence matrix exists for maintenance technicians that help the site understand where the competences are, any gaps that may exist and the status with compliance with legal and mandatory training.

The central training centre has a full time resource dedicated to ensuring that all required maintenance technician training is designed, planned and delivered.

Maintenance technicians have the opportunity of discussing their own further development at end of year appraisals; they also have a personal development plan for the following year. Examples of competence-based assessment for training in this area are; installation of electrical equipment in potentially hazardous areas, and fork lift truck refresher training.

The system will be further enhanced by some of the learning achieved from the PCDM project

A.3.5 The virtual control room, COMAH and PCDM

The company has a virtual control room where it can carry out simulations of emergency situations. The control room is similar to an Operations room, although not an exact copy. Scenarios for events are taken from COMAH safety reports. Individuals are assessed by D32/D33 NVQ assessors against unit 16 of the (PINTO) NVQ standards, in order to be deemed competent in Event Management they have to meet these standards. Two assessors who observe individuals against the NVQ standards carry out the assessment. All assessments are video recorded and assessors can get print outs of the individuals' actions during the assessment. Assessment is carried out on a 2-year refresher cycle, and the training is carried out by an independent body who are ex company employees with experience in the assessed area.

A.3.6 Conclusions

The company uses a systematic method for assessing the tasks that Operators perform, all Operators are assessed on this method by assessors using a variety of assessment methods. Maintenance staff follow a systematic training programme, and there is an assessment method being developed, similar to the one for Operators, to assess maintenance workers.

A.3.7 Key learning areas

- Task analysis is used to provide a task description against which to assess performance
- Hazards are identified to enable prioritisation of tasks for assessment
- There are a set of tests and qualifications required of maintenance staff, along with a task inventory to guide on the job assessment
- Simulators are used to assess control room staff in scenarios selected from the safety case
- HSE critical tasks documented in COMAH are key inputs to the basis of operator work area training plans and emergency response training.

A.4 CASE STUDY C: BATCH CHEMICAL MANUFACTURER

A.4.1 Background

The company has operated in the UK since 1915, and in the last 10 years they have seen an expansion of some of their facilities. They are based on 1 site in the UK.

A.4.2 Selection and training

The company requires process technicians (PT) to have a relatively high level of competence before they enter the system. The reason for this is to allow for less supervision in the process. Individuals are given a series of tests (SHL) to assess for initial levels of competence. Once basic competence is established then they move into the training phase, this is carried out in three stages:

- Exposure to the task
- General Operator training, generic training
- Specific training in tasks

There are then two routes that the individual can take through training, if they are an established PT and the company is working with a new process they will be given classroom training, followed by involvement in the validation of the new configuration of the plant. The other route is for new PT's coming into an existing process, they are also given classroom training and they then move into a system of supervision from a 'buddy'.

The only formal qualifications that the company requires individuals to have at selection are Maths and English at GCSE. Other than this Process Technicians would be expected to have completed the SHL tests at the selection phase.

A.4.3 Competence assurance

The company does not have a standardised method of analysing competent behaviours to carry out tasks, however they are presently in the process of documenting all the competent behaviours that they would require PT's to have. The organisation requires individuals to have appropriate safety knowledge of the equipment they are operating and they are given what the company describes as 'new knowledge tests' to assess this. The test asks the individual about appropriate levels of charging for particular equipment, and hazards that individuals may encounter on the day to day running of the plant.

The company presently operates no formal qualifications for Process Technicians. NVQs were used in the past; however, due to changes in the management structure and downsizing formal qualification training has not been developed fully. Some Operators are qualified to NVQ level but this has never been universal.

In order to assure the competence of individuals the company is moving towards the standard of an annual review for everyone, this will assess for ongoing competence maintenance.

The company presently uses task inventories to assess for competence in high risk and high manual input operations. Their intention is to produce more formal criteria for assessment, by identifying all competences in a job profile.

The company carries out training for people assessing competence, getting them to understand what levels of competence mean. They are also considering doing internal auditing on competence systems in order to ensure that there is standardisation in the competence process.

A.4.4 Conclusions

The company is presently in the process of developing standards in which people can be assessed, changes within the company have affected the ability to provide adequate formal qualifications. The company recognises the need to develop and maintain systems of competence assessment.

A.4.5 Key learning areas

- Company is developing standards for competence assessment to ensure that individuals are capable of carrying out tasks safely and properly;
- The company does require a set level of competence for technicians at the recruitment phase, to ensure that individuals with the appropriate, skills, qualifications and experience are recruited;
- They require knowledge of process hazards and their consequences;
- They apply psychometric tests.

A.5 CASE STUDY D: EXPLOSIVES MANUFACTURER

A.5.1 Background

The company recently merged with another organisation that produced major changes in management structure. The company presently employs about 3000 people spread across 17 locations within the UK.

A.5.2 Selection

The company has a policy of splitting competence levels for tasks into three levels:

- General competence
- Specific competence
- Health and Safety competence

Individuals are selected to work at the organisation through a competence-based interview, typically this interview would assess for health and safety competence. The interview will ask individuals how they would behave in particular situations. For example an interview question may ask the candidate:

- If you witnessed a Health and Safety violation on site and the Line Manager didn't do anything about it – what would you do?

If individuals demonstrate the correct awareness in this area then they can be trained to work on site. Individuals will also answer questions on job specific tasks i.e. if the job requires them to have numerical ability they will have to be able to demonstrate this at interview.

A.5.3 Training for competence assurance

On the first day of training individuals are given an induction session, individuals are monitored to see if they follow induction safety rules. They are presently considering using a retention game similar to a general knowledge test in order to help people retain the information that they learn at induction.

The second stage then involves work place training; this involves being trained in the work packages that have been designed for specific jobs. These work packages are breakdowns of specific tasks that the individual performs in order to carry out work. The work package system was largely engineering driven. The initial design of machinery produced methods and procedures and these filtered through the system to the production site.

Observational assessment is the main assessment method used, if the skill requires accreditation then there will be specific standards for assessors to follow and assessors will have been trained in this area. If there is no accreditation required then it is deemed that the experience of the Line Managers is enough to determine the competence levels of individuals. The number of times that an individual would be expected to perform a task effectively would be down to the Manager in charge. Competence assurance can be monitored through the ISO 9001 system where auditors ask the company how they assess the competence of their people to carry out their work.

It is expected that assessors will be assessed through a new personal development system that is being developed in which competences are measured within a job family system.

The organisation as a rule performs risk assessments on tasks; control measures on the risk assessment will include the competence level of the Operator carrying out the task. If the task is potentially high risk then the company will build into the system a high level of supervision.

A.5.4 Emergency management

The company has internal response systems that they use for emergency management situations and they also have contingency plans on how they would manage an emergency. These were existing systems that were tied into the COMAH regulations.

The company doesn't have a cross organisation approach to emergency response management. Some sites use external agencies to deal with emergency situations and others use internal crews. Major incident plans are practiced once a year and the incidents specified in COMAH safety reports would be used to test emergency response competence.

There is no formalised procedure in the company for linking competence assessment to COMAH, however, they do require all those who are involved in safety to be NEBOSH accredited or to have some other health and safety related diploma.

A.5.5 Safety, health and environment training in development

In part of the organisation they have developed a method for identifying the levels of competence for all employee groups. The method provides a way that staff can be guided towards the right SHE competences and skills for their role. This system is in place on two of the company's sites presently, although it is hoped that it will become active across the entire organisation.

The SHE skills range from basic identification of hazards (level 1) to the management of those who are carrying out hazard identification (level 4). For example if you ask an individual to identify hazards on a basic level, you would expect them to have the following competences:

- Knowledge of site and local fire arrangements
- Knowledge of site and departmental safety health and environmental significant risks
- Knowledge of site and departmental arrangements for managing safety, health and environmental issues
- Clear understanding of roles and responsibilities through Managers, Employees and SHE department

Alternatively if the individual has to advise on and coordinate departmental safety they must demonstrate competence at a much higher level. For example at this stage the organisation would expect them to have understanding of risk management and assessments, and accident investigation. This method outlines and states the assessment level and objective for particular safety related skills.

A.5.6 Conclusions

The organisation trains individuals in competence against specific work packages that have evolved due to manufacturing and engineering pressures. The company is presently developing a more standard system for identifying assessment level and assessment objective for SHE related skills.

A.5.7 Key learning areas

The company presently has SHE skills training in development

- Company requires health and safety competence at the selection phase
- Company considering retention tests for induction sessions

A.6 CASE STUDY E: AIRCRAFT OPERATOR

A.6.1 Selection for Air Pilots

When individuals want to become pilots they have to go through a highly systematic procedure in order to be deemed competent for the task of flying. Aircraft Operators are obliged to follow the licensing rules laid down by the CAA (Civil Aviation Authority) who regulate the industry. The regulator requires individuals to gain specific licences and pass exams. Individuals start by gaining licences to fly small aircraft, progressing to a level where they are able to fly aircraft used by airline operators, the three main licences are as follows:

- Private Pilot Licence
- Commercial Pilot Licence
- Airline Pilot Licence

The exams that individuals take cover the areas of air law, meteorology, navigation and aircraft performance. They also have to complete exams that relate to the specific type of aircraft that they are being trained to fly. Furthermore, individuals have to go through practical flying training, they are required to complete a specific number of hours flying for each licence, and to change to a higher licence.

A.6.2 Competence maintenance process for airline pilots

After pilots have moved through the process of initial selection and training they are then into what the airline industry describes as the 'check and train' phase, this system is conducted under the Air Operators Certificate (AOC) who require individuals to go through a system of regular retraining. The retraining process is overlooked by a strict training structure and involves the following individuals:

- Flying Standards Manager
- Standards Manager
- Training Captain
- Line Training Captain
- Pilots

Within this training structure pilots have to go through a system of conversion training if they wish to fly different types of aircraft. The pilots have to attend a theory course that normally lasts between 8-10 days. There will then be simulator training and training in the aircraft to ensure that individuals have the necessary skills to be able to convert to a different aircraft.

Pilots are reassessed every six months in the check and train phase, and at this assessment the pilots will have there skills monitored in a simulator or live aircraft, typically competences measured include the following:

- Knowledge of specific aircraft systems
- Knowledge of operational rules and guidance material
- Knowledge of handling skills for the aircraft
- Ability to handle a range of emergencies
- Ability to handle systems failures

The main assessment method is by observation by the Training Captain, this observation is guided by the type of task that the individual is performing; they may also complete some written answers and multi choice questions. In the simulator the flight activity will normally be

recorded by video and in these instances pilots will be debriefed on the areas of their performance that could be improved. The main criterion for passing is largely down to the judgement of the Training Captain and passing the written tests that they are given. The Training Captain (TC) will use a matrix drawn up of the minimum competences that are required to complete tasks. Within the matrices and checklists that the TC uses, it will be laid down how much deviation in performance is acceptable, before someone is deemed as competent.

A.6.3 The challenge and response system

Within the airline industry there are systems for monitoring whether tasks are achievable and the compliance of staff to tasks and procedures. One of these systems is the 'challenge and response' system that involves pilots talking through how they carry out tasks when challenged.

In flight operations there will normally be one pilot flying (PF) and one pilot not flying (PNF). During the flight checklists will be used by the PNF to challenge the PF to state how they are carrying out specific tasks. The PNF could be the Commander or Co-Pilot depending on the circumstances at any given time.

A.6.4 Hazard identification and event management

In order to identify the hazards associated with the flying, the company carried out a HAZOP and HAZID analysis to identify the potentiality for human error. The industry also requires individuals to take part in Event Management training, this is covered six monthly along with training in other tasks. Furthermore, pilots are also assessed yearly in Event Management.

Event scenarios are selected on the basis of all the possible emergencies that can be experienced by an aircraft crew. Pilots have to demonstrate competence in all possible scenarios in a simulator. Individuals are assessed against emergency procedure checklists and challenge and response techniques will be used. Pilots have to meet the criteria on the checklists, otherwise there is the possibility that they can be demoted to Co-Pilot.

A.6.5 Conclusions

The airline industry is heavily regulated this has created systems for competence maintenance. Individuals move through a standardised system of initial training, once completed they are then monitored for competence in key skills every six months.

A.6.6 Key learning areas

- Highly structured system of initial training
- Competence check every six months
- Regular checks on procedures through the challenge and response system

A.7 CASE STUDY F: WATER UTILITY

A.7.1 Background

The company has recently been through a merger that has increased its operation to serve 43 million customers worldwide. The company presently employs 14,000 people and is based on a number of different sites in the UK; they also have offices in Australia, Brazil, Chile and China amongst others.

A.7.2 Competence assurance for operators

The company has core health and safety standards that are applied to safety related tasks. The standards specify the following areas:

- Subject of the task
- Introduction to the task
- Hazards associated with the task
- Primary Control measures

The core standards also include recommendations for the standard of training that individuals should receive, their suitability for carrying out the task, assessment recommendations and emergency procedures. For example the task of 'confined space entry' requires the following:

- Staff must be mentally and physically fit for the job
- Each individual must be assessed (see section B:1.1.36) as suitable for the task
- All staff must be trained to identify risks
- Staff, unless under immediate supervision, must be trained in entry procedures, the use of equipment, and emergency procedures
- There should be an appropriately trained supervisor who ensures the effective supervision of all those in the confined space

The core health and safety standards also detail any relevant health and safety publications that are linked to the specific task.

A.7.3 Assessment, assessment criteria and retraining

The core standards were developed by hazard analyses that revealed the key critical tasks that they perform. Some tasks that individuals carry out require them to be licensed in that area; in order to do these tasks individuals have to receive specific training courses. Some tasks do not require licenses; if the individual is going to perform these tasks then their training experience is reviewed in order to ensure that they are competent.

Assessment of tasks can either be a practical demonstration, or in some cases they may have to pass a written examination. The company has developed a matrix that specifies the periods that individuals are allowed to carry out particular tasks without retraining. At certain periods Operators will have to be either refresher trained for some tasks or in other instances they will have to practically demonstrate their proficiency. All safety trainers have City and Guilds training and assessor's qualifications, they also have relevant experience in the operational field.

A.7.4 Event management

The company has a clear event management system that has been developed to attempt to standardise the response that takes place when an event occurs. When an event occurs the relevant line manager is informed and they then assess whether the event is actually serious enough to administer a response, if they decide it is not an event then no action is taken, however if this situation changes the relevant Manager is informed and local action can be taken until the situation is resolved. If the Line Manager deems there to be an onsite event then the relevant Manager is informed and there is monitoring until the situation is resolved. If there is an offsite incident then the line manager informs the relevant manager and again there is monitoring until the situation is resolved. If at any time an offsite incident becomes an emergency then the head of operations is consulted and the situation is brought under control.

Throughout this chain of command individuals have the resource of an Event Support Centre (ESC). This is a service in which one individual is employed to support Managers when an event occurs. The individual has information on relevant phone numbers and safety documentation that can aide those who are in charge of events.

The system operates on the basis that everyone can be an event controller until they inform someone who may be more appropriate to deal with the situation. This system ensures everyone involved has the autonomy and the responsibility to be an event controller. At a certain point in the companies' history they were confident that all their Managers had the right experience within the water industry to be event controllers. However, recruitment campaigns in recent years have seen the company employ more individuals from other management sectors, this has meant that there are more people in the company that do not understand the technical processes in the water industry in order to be able to handle an emergency situation. This has created a need for a training workshop in the area of event management for relevant personnel.

A.7.5 Training in event management

Trainers who have appropriate knowledge of the water industry and have a background in training carry out the programme. One of the trainers is normally an individual who runs the ESC and has detailed knowledge of the procedures that will need to be followed in the event of an emergency.

The training areas are agreed with company personnel as being appropriate topics in the area of Event Management. The training programme was piloted before it was fully delivered and is constantly being adapted to changes. The training for event competence follows six rough areas over a period of two days; these are as follows:

- Event Definition and Event Recognition
- Event Phases and Event Management Procedures
- Risk Assessment and Contingency Planning
- Event Escalation and Event Strategy
- Roles, Responsibilities and Communications
- Stakeholder and Regulator Management

A.7.6 Competence assessment

The company does not operate an assessment of competence for this course. One reason for this is that they are presently unsure of what is a valid assessment method for event management i.e.

how can this behaviour be measured and how accurate could this measurement be. Another reason is that the creation of a competence assessment tool would create a two way split between those who are competent and those who are not yet competent. In the event of an emergency it may be, due to the nature of the emergency structure, that people, who are assessed as not competent to deal with an emergency, are the individuals who initially deal with an event. This has Human Resource consequences and management structures would have to be changed. In the training process individuals are encouraged to assess their own competence as an Event Controller. If they feel they are not competent, they are encouraged to pass on the responsibility for dealing with an event to someone who is more experienced.

There is currently no requirement for individuals to do the training course again as a refresher course, however the company is presently considering developing a refresher course where individuals can build on their experience as Event Controllers.

The company does run observed exercises to check for competence in Event Management. Again there is no pass/fail assessment in Event Management ability, however the performance of individuals is discussed and areas for improvement are suggested. One recent exercise has focussed on assessing the communication systems that are in place in events, another exercise has allowed more junior managers to be involved in controlling events.

A.7.7 Conclusions

The company has standards for all hazardous tasks; these standards specify the competences that individuals will need to do their work. Trainers are all experienced in the field of Operations. The company runs an Event Management training course and, this encourages individuals to self assess their own abilities in Event Management, however there is no formal assessment of competence. The company runs observed exercises in Event Management and these can highlight areas where performance can be improved.

A.7.8 Key learning areas

- Company has standards for all safety related tasks
- Company uses matrix to determine retraining periods
- Company runs training and observed exercises in Event Management

A.8 CASE STUDY G: OFFSHORE STAFF TRAINING CENTRE

A.8.1 Background

The company conducts training programmes for Offshore Installation Managers (OIMs) in several areas including emergency management. The company was formed in 2000 and presently employs 120 people. Their clients come from a wide variety of sectors including the oil and gas, marine and petro-chemical industries.

A.8.2 Competence training programme for OIMs

The company is obliged to follow OPITO approved (Offshore Petroleum Industry Training Organisation) standards in order to provide training to Offshore Installation Managers in the area of emergency control. These standards detail all the necessary criteria and assessment methods that training providers need to follow.

Individuals need to prove their competence in 3 emergency scenarios in order to pass the training in emergency management. The scenarios should be chosen from major incidents that include the following:

- Well Control Incident
- Explosion and Fire
- Accommodation Fire
- Helicopter Incident
- Pipeline Incident
- Collision or wave damage causing structural collapse
- Loss of stability (Mobile installations)

Candidates also have to show their competence a minimum of once in dealing with the following situations:

- Evacuation
- Abandonment of installation/rig
- Injured personnel
- Missing personnel or man overboard
- Loss of communication
- Loss of evacuation and muster points
- Stressed personnel (individual ineffectiveness or mass panic)
- Extreme weather conditions
- Loss of essential facilities
- Loss of key personnel
- Rapidly developing situation leading to information overload
- Loss of mooring (where appropriate)

Individuals are required to be competent in scenarios that their companies have identified in their safety case reports.

These reports outline incidents and scenarios that have a high likelihood of occurrence on their installations. The training is split into six elements of competence (1.1 – 1.6):

- 1.1 – Maintain a state of Readiness
- 1.2 – Assess the situation and take effective action
- 1.3 – Maintain Communications
- 1.4 – Delegate Authority to Act

- 1.5 – Manage individual and team performance
- 1.6 – Deal with stress and others

Element 1.1 "Maintain a state of Readiness" is completed at the individuals company before attending the training centre this ensures that they have the right installation specific knowledge before attending the centre. The training centre then carries out the simulator assessment for elements 1.2 – 1.6

Each of these elements has a series of 'standards of performance', 'evidence requirements' and 'underpinning knowledge and understanding' that individuals need to meet. For example for the task of 'maintaining a state of readiness' the individual needs to able to prove that they can do the following:

- Supply valid and reliable, oral and written information to relevant personnel
- Ensure that drills and exercises are consistent with priorities, objectives, procedures and statutory requirements
- Coach the Deputy OIM, the Emergency Management and Response Team and assess their potential to respond to emergencies during drills and exercises
- Encourage personnel to seek clarification of their allocated roles and responsibilities
- Pre-plan actions to deal with potential emergencies
- Confirm the serviceability and sufficiency of equipment in accordance with procedures

A.8.3 Competence assurance pass/fail criteria systems

The main form of assessment of individuals is a realistic simulation demonstrating the core elements and tasks. All simulations are conducted in a mock control room that is typical of control rooms found on offshore installations. All simulations are recorded and can be reviewed at later dates for assessment purposes. The main assessment method is direct observation. Two assessors carry out the assessment, the team includes a qualified assessor and a task expert – this is someone who has been in a position of authority on an installation. (If possible an individual who has worked as an OIM on the installation or one similar should be involved.)

Individuals have to meet relevant pass or fail criteria for everything they are assessed on. For example in element 1.2 which is 'assess the situation and take effective action' one of the elements that is required for effective performance is ensuring that the appropriate resources are utilised throughout the emergency for this the individual has to be competent in certain criteria including the following:

- Utilising emergency response teams including medical back up
- Utilising portable equipment
- Utilising resources from onshore bases
- Utilising resources from adjacent installations

For every 'standard of performance there are similar performance criteria that individuals have to meet in order to be deemed competent.

A.8.4 Assessment

Individuals are required to have core essential knowledge in relation to their position. For example, this includes having appropriate knowledge in procedures for safety cases and emergency response. Furthermore, individuals need to have appropriate core essential knowledge in the hardware they are working with, information systems and human factors such as stress and communication techniques. Individuals are also required to have knowledge of

potential hazards specific to the type of installation they are working on and to have experience that is appropriate off shore. The individuals would have demonstrated this knowledge before attending the course and this would have been approved by a supervisor in their company.

The Training Centre will ensure that individuals have the appropriate knowledge by, remote review of the records of each trainee, that are supplied to them before the assessment. Through question and answer techniques they can further ensure that the individuals' experience has been suitable for the training, if they are uncertain that the individuals' experience is appropriate they could then suggest that the individual gets more experience off shore first. At this stage a representative from the individuals company could be present to endorse that the individual has appropriate knowledge.

After the assessment in the simulator individuals will have assessment debriefs and in this section they will be given the opportunity to explain why they performed particular actions in the manner that they did, this allows assessors to probe the underlying knowledge of the individuals through question and answer techniques.

Attention should be focused on the hazards that are identified in their companies' safety case report. Some areas can be assessed separately from the simulation when necessary, i.e. it may be more appropriate for some knowledge to be assessed on the installation.

Assessors are made aware that the assessment of competence is down to their judgement and they should always ask the following question before judging someone as competent – "having had regard to all of the information and evidence available, is this person capable of making the correct decisions and taking the correct actions in a real emergency". Assessors are encouraged to seek advice from others when they make an assessment of the competence of individuals, these could be other assessors who have witnessed the individuals' performance in the simulator or individuals who have witnessed the candidates performance on-site. Candidates are at all times given the opportunity to justify their actions within the assessment.

The process of re-assessment is driven by the companies' that individuals are working for and there is no requirement for the training centre to ensure there is re-assessment. The UK Offshore Operators Association Limited (UKOOA) recommend that individuals should be refresher trained every three years with regular offshore practice.

A.8.5 Conclusions

The company follows industry-approved standards to train OIM's in the area of emergency management. Individuals must demonstrate competent behaviours in a series of tasks that are based on likely events on their installation from the safety case report. Re-assessment is 'off-shore' company driven, although the recommendation is for reassessment every 3 years with regular practice offshore.

A.8.6 Key learning areas

- Scenarios are taken from safety cases
- Formal pass criteria are defined
- Managers must handle at least 3 scenarios

- A task inventory is used to ensure systematic and comprehensive assessment
- Assessment covers softer competencies of team management as well as technical and procedural knowledge
- Assessment also covers platform specific knowledge

A.9 CASE STUDY H: PHARMACEUTICALS MANUFACTURER

A.9.1 Background

The company has Operations worldwide, they have sales services in over 100 countries, manufacturing in 20 and major research centres in 5. The company presently employs 54,000 employees.

A.9.2 Competence assurance for process operators

The company used task analysis to break down all the tasks that Operators would be involved in. They developed training plans from this task analysis and Operators are trained against these standards. The training is trainee centred and when the individual feels competent; trained coaches coach them. The task analysis system identifies safety related aspects of the work that Operators carry out, and the batch sheets have key safety related prompts. Technicians and Operators were involved in the initial task analysis to say what tasks they carry out.

After the Operators are trained the system of long-term competence assurance is different dependent on what site the individual is based. One site operates a refresher training system every 3 years as a norm, however they could go to a maximum of 5 years. Frequently performed tasks would not be retested in the same way. This site has a system where Shift Coaches are present on all shifts to deal specifically with any training issues that may arise. The shift coach would normally come from a background of running process units themselves. They are given what the site calls Criterion Reference Instruction training (CRI), this training gives them experience in understanding the process of training. For example they will learn the process of how the task analysis is developed for batch sheets and how the training modules around this system are developed.

Another site interviewed doesn't have a shift coach system in place and doesn't have a specific refresher training procedure. They do have compliance training whenever there is a change in the batch sheets and these training sessions can run every six weeks. New Operators have to shadow trainers and the trainers will have gained their trained to train qualification. This system is monitored by Line Managers. The differences in competence assessment systems between sites have been caused by the historical differences in tasks that they carry out.

For both of the sites the principal assessment method is observation of tasks being carried out. For example the shift coach on one of the sites would observe the task being performed and if they were satisfied they would deem the individual as competent in that area. Trainees also have self-evaluation sheets that they can use to test their own performance. Sites have individual development plan reviews, one site has these reviews on a quarterly basis and the other has reviews on a six monthly basis. These reviews could also pick up deficiencies in performance.

Furthermore, the company has a SHE audit system that can assess whether individuals are carrying out tasks effectively and safely. Moreover, changes in the batch sheets are closely monitored and risk assessments are carried out, if there is deemed to be anything safety critical about the task then this is highlighted on the Batch sheet.

The company does not have a standardised procedure for determining suitable on the job experience for individuals. The shift coach should be happy with the level of performance that

the individual is demonstrating. The more day-to-day operational experience they have is important however it could take individuals longer to gain exposure to some tasks than others.

The company does not operate a standardised NVQ system, individuals can go through the NVQ process but this is entirely optional. There are other chemical operators courses, however these are also optional. The company considers their internal training to be equivalent in standard to the NVQ system. The company identifies that there needs to be more consistency between their sites and recognises the need for techniques to assist them in doing this.

A.9.3 COMAH and competence assessment

The company has a system of identifying all potential hazards and these appear on the batch sheets and training plans for Operators. The company has a SHE training programme that it feels covers the requirement for competence assessment to carry out safety critical tasks. The company is considering building information from the COMAH safety cases into their SHE training programme. The company will be using their COMAH safety report to help Line Managers identify the consequences and significance of their actions.

A.9.4 Conclusions

The company has a system of standardising tasks and ensuring that every task has a training strategy. The company recognises the problem of standardising methods across their sites and is keen in developing strategies to do this.

A.9.5 Key learning areas

- A form of task analysis is used to ensure they have a valid task description against which to assess people
- The frequency of re-assessment is matched against task frequency

A.10 CASE STUDY I: POWER SUPPLY COMPANY

A.10.1 Background

The company presently employs 3000 people, however there may be downsizing and redundancies in the near future; there is also the possibility of a merger with another company. The company has 270 sites that are between 275 kv (kilovolts) and 400 kv. They presently operate in England and Wales and have inter-connectors to Sangatte in France. The company was fully privatised in 1990.

The company has around 1000 people who are involved in safety critical tasks. The company splits the competence to do tasks into two levels; competence to carry out work, and competence to do tasks safely. There are four categories of staff:

- Person
- Competent Person
- Authorised Person (AP)
- Senior Authorised Person (SAP)

The individual would move through these particular grades with the lowest 'person' level being the lowest competence level to carry out safety critical tasks, and SAP being the highest competence to carry out safety critical tasks. This case study only describes the process for becoming an SAP.

A.10.2 Pre-course requirements for SAP training

Before the individual is trained to be an SAP it is recommended that they go through a selection process and that they have experienced certain on the job activities.

The SAP would be the person on site who would be responsible for tasks like demarcation of sites for work, all the safety documents associated with a particular task and portable primary earths. Selection for being a SAP comes under three stages:

- Obtaining the correct qualifications/experience
- Competency based interview to assess aptitude and attitude
- Having selected an individual, satisfying the pre-course criteria

A.10.3 Obtaining correct qualifications

In order to have the right qualifications and experience the individual could produce evidence of logbook entries indicating appropriate personal developments. They could show they have the correct academic qualifications for the job or produce the relevant authorisation certificates. The right qualifications will be dependent on the candidates' present role, for example a Technical Engineer would be expected to have an HND or an NVQ level 3 or 4. The experience that individuals would be required to have will also be dependent on role type, the Technical Engineer would be expected to have completed; 6 Permits for Work (PFW), 2 Sanctions for Work (SFW), 2 Limited Access Certificates (LAC) and 2 Certificate for Live Low Voltage Work (CLLVW).

A.10.4 Competence based interview

The individual would then go through a selection interview, before the formal training, that would focus on their competence in the following areas:

- Making appropriate decisions
- Supervising staff
- Saying no
- Assessing risks and priorities
- Identifying individual commitment (i.e. Working in own time)
- Planning/Organisation
- Communication – must be able to communicate with others competently
- Team working

Samples of behaviour are taken as evidence for the competence criteria in the pre-training SAP interview. The line manager or an unbiased independent person who has knowledge of the individuals' specific work area chooses these samples. An example of this would be discussing the following questions:

- Using a simple schematic diagram test the individuals' knowledge to achieve "Safety from the HV System" by isolation and primary earthing on for example generator circuit 196.
- Utilising a pre-prepare safety document which has deliberate errors and mistakes detailed on it, assess the individuals knowledge to pick out the errors and mistakes.

The criteria for deeming a person as appropriate for SAP training is down to those interviewing and it is their judgement of whether the individual has the right qualities and competences specified by the interview.

A.10.5 Pre-course experience

Those selecting potential candidates for SAP are encouraged to ensure that candidates are selected on appropriate ability and aptitude and that they attend the relevant managing safety courses. Individuals must be Authorised Persons (AP) and should have recently practiced as an AP. Individuals should have a good understanding of risk assessment, candidates should also satisfy trainers that they are competent in all pre-course criteria set out, these include completing set periods of pre-course on the job experience (e.g. qualified craftsmen are recommended to complete a 6 month period on the job). Individuals are recommended to have achieved the following:

- Appropriate number of safety documents
- Must have attended weekly planning/pre access meetings and acquire a good understanding of the importance of planning for health and safety, in order to set people to work safely.
- Received on the job training in building project/work packages writing method statements and risk assessments for a period of several weeks
- Dates organised for first stage/final interviews and Network Operations Centre (NOC) visit.

- Arranged a mentor – evidence provided that work with an appointed Mentor has been completed
- Dates organised for practical SAP assessments
- Must have completed a Managing Safety Course
- Must be practising AP and successfully passed AP assessment.
- Must be able to read schematic diagrams and have gained practical experience on protection/control systems

A.10.6 Formal SAP training

Overview and objectives

The training period lasts approximately 15 weeks, with each trainee receiving 15 days tuition by an internal trainer and 4 days tuition by an external trainer. Each trainee must receive at least 1 hour a week with a mentor to discuss any problems that may arise.

It is expected by this time that the individual has acquired appropriate pre training experience. Formal training then provides the finishing touches to this experience. The training centre consolidates the 'on the job' training experiences of the individual.

Course objectives

The main objective of the course is to guide the trainee to be able to "set people to work safely". Individuals will be assessed in their ability to do this by an interview panel. The trainee should be developed to achieve the following:

- Establish safety from the system
- Establish general safety
- Ensure safe systems of work are developed and implemented

SAP's should at all times be aware of their roles and responsibilities. Candidates are expected to develop the skills of a risk manager in order to guide people in their safety critical work. Individuals should be aware of the work that they are authorised to do.

Training period

Week 1 – Individuals are based at company training Centre.

Week 2 – 5 – Candidates receive on the job training by carrying out practical exercises and learning about the documentation that is relevant to the post of SAP, at this stage the trainee should meet with his or her mentor (once a week throughout). The mentor should also use this time to ask scenario based questions based on the trainees experience. Individuals should also meet with the trainer at this stage to discuss any possible difficulties. This should carry on until week 9.

Week 6 – Individuals return to the training centre, at this stage they will receive an interim assessment by the trainer. This takes the form of a report of the trainee's progress

Week 7 – 8 – Trainees will visit the NOC.

Week 9 – Candidates will do a period of 'on the job' training in an area/operating unit. At this stage individuals will have their last meeting with the trainer. Individuals will also cover some safety procedures at this stage.

Week 10 – Individuals will do a practical assessment at this stage in conjunction with the NOC. The trainee will have organised this prior to the start of training. This assessment involves the individual carrying out a piece of work in live operation (e.g. they have to manage a piece of work from a work package, ensuring all safety documents are applied in the correct way, and that the staff they are supervising are set to work safely). A supervisor is present throughout this assessment monitoring their performance

Week 12 –14 – First stage interview

Week 15 – Final stage interview

A.10.7 The SAP assessment

First stage interview

This interview enables trainers to see if the individual is ready for the final assessment. The interviews should take place 2 weeks before the final interview. Individuals are able to correct any errors in performance prior to the final interview. The interviewers at this stage should be the Operating Unit Authorisation Officer and a group of Line Managers as this is a company requirement.

If the trainee is unsuccessful at this interview then the final assessment will be deferred. The individuals' line manager will need to re-evaluate the trainee's performance to see what additional training is needed. The Operating Unit Authorisation Officer should be informed so that the final assessment can be reset.

Final assessment

The final assessment lasts between 3-4 hrs in length and is conducted by a Senior Safety Officer (SSO) who is normally the individual that is authorised to ensure that the trainee is competent to practice as an SAP. The SSO will normally be NEBOSH certificated and a member of the institute of occupational health. The SSO will also have worked as an SAP.

Individuals are measured on the following competences:

- Risk Management, i.e. ability to produce risk assessments
- Competence to set people to work safely
- Competence to achieve safety from company systems i.e. low voltage and high voltage systems.
- Competence to establish general safety.

The interview measures competence by surveying the individuals' log of experience from the training, this has records of all the jobs they have carried out and all the practical experience that they have had. The interview will also look at the individuals' practical assessment that was carried out in week 10 of their training; this can be further reviewed by an audio tape recording that is taken of the event. The interviewers then get the individual to answer scenario-based questions.

The interviewers have to be confident that individuals have demonstrated an ability to manage risk and that they are competent to set people to work safely and maintain a safe system of work.

Post SAP assessment

After completing the SAP assessment, individuals will go back into the work place, here they will be given low-level tasks to begin with and a high level of support for new SAP's will be expected. Line Managers should review performance on a yearly basis and at this review the individual's performance will be assessed and any weaknesses will be identified. If the individual is lacking any experience in any areas, then training in this area could be specified. Poor performance could mean that SAP status is taken from them and that they go through the process of re-training for SAP status.

Every year at review SAP's sit the 'Competent Persons' computer based training package which tests the individuals' knowledge of specific safety procedures and instructions. There is currently a computer based training package in development that tests scenarios in SAP level. Furthermore, individuals are refresher trained every 3 years and at this stage they are given a computer based assessment exercise and a pen and paper test.

A.10.8 Conclusions

The company has a designated role structure in which the most senior (SAP's) individuals are given the safety critical tasks. To be considered an SAP trainees have to go through a structured training programme where suitably experienced individuals give them an interview assessment. If they are successful at this stage they are then reviewed on an annual basis with computer based assessment, and they are further given refresher training every three years.

A.10.9 Key learning areas

- Individuals are given worker status on the basis of their ability to carry out safety critical tasks
- Individuals have to go through a scenario based interview and on the job supervised assessment in order to ensure they are competent
- Being able to ensure safety from the work system is the main criteria for becoming a Senior Authorised Person

A.11 CASE STUDY J: CHEMICALS MANUFACTURER

A.11.1 Background

The company employs around 3200 people in northern Europe, of whom 2647 are based in the UK at five different sites. Overall the company employs 19700 individuals worldwide, they have 1500 research and development staff in 11 countries and 64 production sites in 25 countries.

A.11.2 System of competence assurance for operators

The company in the past used to operate a system of NVQs to assess the competence of individuals to carry out work related tasks. They found that the implementation of NVQs was difficult, as they didn't cover all the operations that individuals were likely to carry out in live operation. Furthermore, they tended to find that the requirements of the task were NVQ driven without an understanding of company standards.

The company then decided to develop their own requirements for safe work keeping NVQs as another system of competence measurement. The company analysed Operators' jobs and their location and they noticed a huge variation in the way that tasks were carried out. They then created job titles for everyone and documented the procedures that individuals were involved in carrying out. The new system breaks the procedures down into manageable units in which individuals can be assessed. All procedures highlight safety critical aspects of tasks. The company found that the NVQ process only required individuals to be competent in some procedures, whereas the present system requires them to be competent in all procedures that they carry out. Operational staff wrote all the procedures that the company are now using and this has produced agreement in the work force on how tasks are completed.

A.11.3 Training and competence maintenance

Individuals receive initial training by suitably experienced trainers, the trainers normally have the NVQ D32/D33 assessor accreditation and would be expected to have 5 years or more experience in the field, dependent on the nature of the plant (e.g. some plants are completely automated).

Training is on a 1 to 1 basis with the trainer; in this process individuals are trained in how to carry out the relevant procedures for their job. Some specific procedures require the individuals to attend specific training courses. For example some procedures would need the Operator to have attended a course in 'manual handling'. The company also runs COMAH awareness sessions for Operators; these sessions may be assessed by a questionnaire at the end of the session or by ongoing assessment by the line manager. Some COMAH sessions do not have any assessment. In the COMAH sessions individuals are encouraged to understand the potential for major accidents, the sessions also get individuals to understand that they are part of the accident control process.

The assessment methods for procedure training are 'observation' and 'questioning'. With observational assessment the individual has to be observed doing the task once. The company is presently in discussions to see if this is an appropriate number of times to observe a task being completed. They are considering whether a task should be observed on three separate occasions

in order to ensure that an individual is competent to carry out tasks. The individuals are marked against criteria that are developed from the task inventories.

The Individual also answers questions that are directly relevant to the task they are conducting, examples of these include:

- Why are valves throttled back on some feed lines?
- What do you check if machinery is taking a long time to cool?
- What action do you take if the fire alarm goes off?
- What action do you take if the PH is out of range in the outside storage tank?
- What extra tasks should you undertake prior to an extended shutdown?

Individuals have to get all the questions they are asked correct in order to be deemed competent to carry out tasks.

The process for re assessment and competence maintenance would be driven by changes in the procedures. Decisions could be made that some procedures have priority and that reassessment could be required. There may be a system in the future for having reassessment built into their procedures. The company has a performance review system on an annual basis and this covers overall and generic aspects of the job.

Documentation of the individuals training is kept and internally verified to ensure that assessors and trainers are carrying out their jobs effectively, this also ensures that individuals have been trained to carry out safety related tasks. Furthermore, they have internal and external NVQ verifications.

A.11.4 COMAH and competence assessment

The company is developing a system in which the procedures that are potentially high hazard in terms of COMAH are given priority. They are presently in discussions to determine how often tasks, that have a high COMAH priority, should be assessed.

A.11.5 Conclusions

The company has developed systems for putting tasks into procedures so that individuals can be assessed for competence. Individuals are assessed by observational and questioning methods, these methods were developed when the company found that NVQs did not meet their requirement for assessing competence to carry out tasks.

A.11.6 Key learning areas

- Used COMAH safety case to identify safety critical procedures
- Assessment includes knowledge tests as well as observation
- They use accredited trainers with process experience
- All tasks are decomposed into manageable units
- They went beyond NVQs to ensure site specific knowledge is appraised

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