A guide to enhancing process safety and plant efficiency through the competence of Control Room Operators (CROs)

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Control Room Operator (CRO) skills are critical to avoiding errors that degrade plant performance and safety as well as handling faults and emergencies. Key CRO competencies include understanding plant state, gathering and interpreting data, process monitoring and fault detection and handling process upsets. CROs must understand process and plant function across normal, abnormal and emergency operations, detect process abnormalities, maintain situational awareness of plant status and take action to optimise plant operations across these conditions. However, many sectors are experiencing a shortage of skilled CROs, with shortages intensified by competition for skilled labour and succession management problems. As the workforce gets older, there is a vital need to increase the supply of new operators. Coupled with an ageing workforce, are ageing facilities with the increased risk of equipment failure as equipment approaches end of design life – placing greater demands on CROs. Furthermore, increased complexity and automation of plant requires a high level of expertise for safe and proper operation, particularly when automation fails.

Organisations need advanced competence management arrangements to meet these challenges. Consequently Greenstreet Berman Ltd, on behalf of the Energy Institute, has created a best practice approach to assuring CRO competence (termed the "SMARTAR" approach). The guidance has been scoped to address the problems identified by companies operating high hazard facilities. The guidance is based on best practice from leading companies within high hazard industries (including oil, gas, aerospace, nuclear and others); principles of adult learning (linking new information to existing knowledge, opportunity for reflection and practice, adapting to individual cognitive and learning styles); crew resource management; occupational psychology (psychological techniques such as Repertory Grid and Critical Incident Technique to validate and enhance training and assessment) and Human Factors of safety critical operations. The guidance is being peer reviewed and scrutinised by subject matter experts.

This approach is specific to the competence issues facing CROs including building on national competence standards to meet plant specific requirements; selection and talent management of CROs, developing, assessing and assuring on-going technical and non technical skills across all modes of operation; developing CRO assessor and trainer competence. The guidance includes skills, knowledge and behavioural competence models specific to routine, infrequent and abnormal operations and emergency responses, for CROs, trainers and assessors; talent management strategies for developing and retaining future CROs; model approaches to training CROs in technical and non technical skills such as situational awareness, fault diagnosis, interpersonal communications and decision making in emergencies; technical and behavioural criteria and rating methods for the assessment of competence, across modes of operation, utilising cognitive walkthroughs and observations, simulators and simulation; and best practice case studies.

The guide goes beyond competence to outline key organisational support in the form of leadership, practical procedures, ergonomic control rooms, supervision and effective change management.

This paper discusses the CRO competence challenge and its effects on process safety and efficiency. The paper then discusses the objectives of the SMARTAR approach, along with a detailed description. Finally the paper will describe how this approach can be implemented and the benefits this will bring.

Keywords: Competence Management, Control Room Operators, Competence Assurance, Training and Development, Control Room Operations.

The CRO competence challenge

CROs interface with the plant within the control room, with direct responsibility (hands on control) for control room operations. They are required to complete a diverse range of tasks, underpinned by technical and non-technical knowledge and skills. For example, they must understand the plant in normal, abnormal and emergency conditions, interpret information to establish and maintain situational awareness of plant status and take actions to optimise plant operations in all conditions. They must also communicate this at shift handover and assist in training other CROs. In addition, CROs may be required to undertake infrequent tasks such as start up and shut down of plant as well as other central control room duties such as issuing work permits, managing loading and unloading operations and record keeping.

Developing and assuring the diverse competence requirements of CROs can be a significant challenge[1,2]. The following are a set of critical challenges in ensuring the competence of CROs, identified and prioritised by industry, as part of the guidance development process utilising a user requirements workshop and extensive industry consultation and review.

1 Larson, K. (2012) Operator Effectiveness: The Next Frontier of Process Automation. ABB and Control White Paper

2 Kluge, A. & Burkolter, D (2010) Comparative study of three training methods for enhancing process control performance: Emphasis shift training, situation awareness training, and drill and practice. Computers in Human Behavior. Vol 26. Iss 5. pp 976-986

Using CRO standards

The skill set required of a competent CRO is a combination of generic skills and knowledge about how to operate complex plant along with very specific plant and site knowledge and skills. The challenge for organisations is how to build on industry CRO standards and training, to develop site specific CRO competence requirements and effectively inform ongoing competence development and assessment beyond a one-off qualification.

Managing the talent of CROs

As the workforce gets older, there is a need to effectively manage talent. Due to the diverse range of tasks and skills required to be a CRO it can take a long time to train a potential CRO to full competence, the challenge for an organisation is how to fill posts, in a timely manner, with competent qualified CROs. This process can be costly if the initial assessment of a candidate's potential to become a CRO is inadequate and subsequent ongoing training and development does not develop the right competencies and build the correct level of competence. The process also needs to ensure that potential CROs are not fast tracked too quickly and are instead provided with the time to develop experience and knowledge of plant operation and process.

Retention of qualified CROs can also be a significant and costly challenge, as talented CROs may be tempted to move to other organisations once they have developed a certain level of competence. Talent management therefore needs to continue after an individual has been recruited to the role of CRO.

Training, assessment and assurance of CRO competence

The challenge for any organisation is how to ensure CROs are continually trained and assessed in the right competencies, and can demonstrate these over time, especially developing and assuring competence for abnormal and emergency response situations, which often occur infrequently and can be difficult and expensive to effectively simulate. Workload demands and shift patterns of CROs mean that organisations must optimise training approaches utilising a range of methods (for example simulation and/or simulators) to provide realistic environments in which to train and assess competencies. This optimisation relies on the competence of the trainers and assessors. Organisations must ensure these trainers and assessors have the required technical and non-technical skills to provide effective and robust training and assessment.

Supporting CRO competence and responding to change

A number of factors can affect the performance of CROs, such as design and implementation of procedures, control room design, supervision and leadership. Moreover, it is important to note that CRO competence is just one risk control measure and a significant number of other risk controls, including the factors just described are needed to help prevent major accidents. It is critical therefore that organisations put in place relevant organisational systems that support CROs to apply their competence as well as manage knowledge that can be lost when CROs move roles. Organisations must also effectively manage change and understand the impact change can have on CRO competence requirements, and review such requirements, when change occurs.

Overcoming these challenges can bring significant benefits to organisations, including:

- Process safety and operational efficiency. Competent CROs have improved diagnostic accuracy and speed as well as process control operation[3], which can lead to high reliability/integrity operations. Indeed 86% of process automation professionals indicated operators had a significant impact on quality, while 78% felt they had a significant impact on the economic performance of the plant[4].
- Cost savings. Effective training can help reduce plant damage, increase plant availability and save on training costs, estimated at roughly $4,500 per megawatt of generating capacity per year by the Electric Power Research Institute[5].
- Compliance Improvements. Competent CROs have greater underpinning knowledge of procedures and process safety risks. CROs understand why procedures need to be followed and are more likely to support and comply with them.
- Increased participation in safety. Increased competence and understanding of process and risk means individuals start to take greater responsibility for safety and can demonstrate greater participation in safety initiatives and programmes.

This illustrates the increased need for guidance tailored to helping organisations overcome such challenges.

SMARTAR Competence Management of CROs

The Energy Institute, in response to membership, identified the need for guidance to help organisations address specific challenges relating to ensuring the competence of control room operators as described above.

3 Kluge, A., & Burkolter, D (2008) Training principles for process control tasks and innovative approaches to training.

4 Larson, K. (2012) Operator Effectiveness: The Next Frontier of Process Automation. ABB and Control White Paper

5 See 2

To meet this need the SMARTAR model of CRO competence management was developed. SMARTAR builds on current models of competence management to provide a tailored approach to help organisations address the specific challenges faced ensuring CRO competence. The guide is built around the SMARTAR model, focused on optimising and assuring CRO competence for routine, infrequent, abnormal and emergency response tasks to support the effective control of major accident hazard.

SMARTAR is presented in Figure 1. A more detailed description of each element is provided as follows.

Standards

This element is focused on how to make best use of and build upon CRO standards, regulations and standard industry wide training to inform plant specific CRO competence requirements and create effective ongoing CRO training and assessment programmes. Several 'building blocks', collated from research[6,7], are presented in the guide, to help organisations build on CRO standards, regulations and off the shelf training to ensure that they effectively help to meet plant specific CRO competence requirements. These are:

- Building block 1: Describe CRO competence requirement to determine relevance and where additional elements or modules are needed to meet plant requirements. Specific consideration given to the task type (routine, infrequent, abnormal and emergency response), criticality, complexity and frequency of performance as well as the competencies required, e.g. generic or site specific, technical, non technical and the level of competence required/expected.
- Building block 2: Map plant specific CRO competence requirements onto the CRO standards, regulations and off the shelf training, and identify and develop additional modules to meet competence requirements. The development, review and validation of additional modules allow the organisation to build on standard, off the shelf training etc.
- Building block 3: Implementing standards, regulations and/or off the shelf training and any additional modules/elements, with detailed consideration of the approach to roll out across a plant or organisation; the ongoing training and assessment requirements based on the CRO competence description; communication requirements to support implementation and methods for reviewing the effectiveness of the CRO standards, regulations and off the shelf training.

Figure 1 SMARTAR Model

6 OPITO International issue 1. (2010) Guidance for Effective Management of Competence and Training in Emergency Response in the Oil and Gas Industry

7 Scottish Qualifications Authority (2007). Assessor's Guidelines for the SVQ in Processing Operations: Hydrocarbons at level 1, level 2 and level 3 and Processing Operations: Hydrocarbons (Control Room) at level 3. Publication code: DB1576/2

Manage talent

This element is focused on ensuring the competence of potential CROs, through initial assessment of potential, developing and assessing this potential over time and continuing the management of talent after an individual is selected for the role of CRO. This element is also focused on enhancing retention of qualified CROs. The FUTURE model, drawn from best practice in talent management[8,9], has been created and presented in the guide to help organisations develop and implement a planned strategy for managing the talent of potential CROs. FUTURE provides six key areas:

- Formalise. Potential CROs will go through a number of critical development stages during the talent management process before they become qualified CROs. These should be formalised along with the competencies that need to be acquired to achieve each stage. This should include relevant qualifications required for each development stage, along with specific type and duration of experience required. A Talent Management Development Ladder has been developed and is presented within the guide to help organisations think about the different development stages their potential CROs may go through and the example competence types for each stage.

- Understand potential. Assessing potential to be a CRO is critical to successful talent management and should involve a range of different methods. The assessment of potential should focus on three critical competence types/attitudes: the critical cognitive abilities to maintain situational awareness of plant functioning; the critical non technical skills to be able to work effectively and safely within a control room environment and, the underpinning working style, values and beliefs that fit the culture of the organisation. The guide provides examples of assessment methods for each.

- Train potential CROs. To ensure effective development of CROs training should be mapped to the development stages. A range of initial training approaches should be used especially approaches like on-the-job training, shadowing, observations, scenario exercises and job rotation. This is because these approaches help maximise CRO exposure to plant and control room operations helping build CRO competence experience.

- Understand strengths and weaknesses. The talent management process should build a portfolio of evidence to demonstrate the extent to which potential CROs are progressing through the development stages as expected, acquiring and demonstrating the right competencies to the standard required. To build a portfolio ongoing assessments of competence should occur, matched to the development stages and specific competence types being developed, utilising multiple methods and structured around relevant technical and/or non technical markers.

- Remain focused. Ongoing competence assessments identify strengths and weaknesses of potential CROs to help inform the type and level of ongoing training and whether re-assessment or additional types of assessment are required. Proactively using assessment results to remain focused on competence needs of potential CROs can help to reduce the risk that assessments become a 'tick box' exercise.

- Evaluate. Final stage assessments are often a critical part of the talent management process. To be effective they should focus on the demonstration of core safety critical technical and non technical competencies required across routine, infrequent, abnormal and emergency response conditions. The final assessments should maximise work sample tests, as they allow both technical and non technical knowledge and skill to be assessed. The guide details example methods to use as well as how to develop a formalised retention plan for all individuals who pass the final assessments, detailing the types of activities and processes that will/are in place to help retain these CROs.

Analyse and Revise

This element is focused on utilising psychological techniques to ensure the right technical, non technical competencies and training requirements are identified for CROs, across routine, infrequent, abnormal and emergency response conditions; and that these are matched and prioritised according to major hazard risk.

Best practice in task analysis and risk based job and training needs analysis[10,11] suggests there are four key principles for successfully identifying and/or validating CRO competencies to ensure the right technical & non technical competencies and training requirements for CROs. The four principles, described in the guide are:

8 Berger, L. & Berger, R. (2011) The Talent Management Handbook: Creating a Sustainable Competitive Advantage by Selecting, Developing, and Promoting the Best People. McGraw-Hill Professional. ISBN-10: 007173905X

9 Calo, T. (2008). Talent management in the era of the aging workforce. The critical role of knowledge transfer. Public Personnel Management. Vol 37. No. 4. Pp 403-416

10 Energy Institute. (2011).Guidance on human factors safety critical task analysis. ISBN 978 0 85293 603 0

- Tasks. Identification of safety critical CRO tasks for all relevant forms of control room activity, with consideration given to the process/operation type, for example batch vs. continuous operations, any relevant supervision/team leader duties that may be critical for the control of Major Accident Hazards; complexity of tasks and how often they are performed. This also includes validated this analysis, for example, comparing task analysis to the risk assessments described within the safety case to ensure all relevant major accident hazards and associated CRO tasks have been considered and identified.
- Competencies. Analyses of CRO safety critical tasks, using techniques such as Critical Incident Technique Task Steps and Repertory Grid Task Steps supported by information gathered from reviewing relevant procedures, observations and structured talk/walk-throughs and safe case review to identify all relevant technical and non technical skills and knowledge required to carry out the task described reliably and safely. These can then be prioritised and turned into technical and non technical markers to underpin initial and ongoing CRO competence assessments.
- Measurable statements. Development of these statements of performance describing what comprises 'competent' performance for each safety critical task, based on the CRO grade. These can then be used as learning objectives for any type of CRO training and standards of performance for initial and ongoing CRO competence assessments.
- Training needs. Identification of training needs, that is, the training required to develop the technical and non technical skills and knowledge CROs require to carry out their safety critical tasks reliably and safely to the standard described in the measurable statements of performance, with specific consideration of frequency of performance, task difficulty, criticality of the tasks, skills vs. knowledge.

All of this information can be represented in CRO task inventories for each operational condition to guide and track CRO training & assessment requirements.

Train

This element is focused on ensuring CROs are trained in the right competencies, across operation modes; and that training approaches are mapped to the criticality and competency type. Research[12,13] indicates that training and assessments are often more successful if they are structured around the psychological principles of adult learning. Key principles relevant for CRO training and assessment include:

- Motivation. CROs may resist learning that is imposed on them. Fostering responsibility for learning will help to motivate CROs and can improve the learning experience. Techniques such as graded learning programs, group and individual activities that require CROs to take the concepts, theories, and information and generate learning outputs for themselves, will help to create motivation.
- Experience. Experience is a source of an adult's identity. Knowledge and skills being presented and taught to CROs should be integrated within their own experiences so that this knowledge and skill complements or supplements their existing knowledge. Interactive group activities can provide the reflective learning opportunities and peer feedback to facilitate this process.
- Learn by doing. Adults learn by doing and prefer to take an active role in their learning. CRO training should always involve a high level of practice/application, both within a specific learning environment and the workplace. These activities should be set within a context that a CRO can relate to and focus on helping them tackle/solve problems that they commonly face. Activities should always be supported by feedback from the trainer/assessor and peers that is objective, specific, motivating and structured around relevant technical and non technical markers.
- Respect and trust. Adults will learn better if they are respected and they trust the trainer (i.e. confident that the trainer has the necessary skills, knowledge and experience). Effective facilitation, such as using open ended questions, encouraging CROs to express ideas, reasoning for thoughts and decisions and providing constructive feedback at every opportunity during CRO training can help to create trust and respect.

The guide describes these principles in detail, coupled with guidance on how to use them to structure CRO training.

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11 Rail Safety and Standards Board. (2011). Risk based training needs analysis. Guide to the process and templates. Operations and Management: Review of GB driver training and development of leading practice models for the industry. Guide to the process and template

12 See 2

13 Rail Safety and Standards Board. (2013). Good practice guide on competence development. Document No RS/100 issue 1

Assess

This element is focused on ensuring CROs have acquired the right competencies and can demonstrate these on a continual basis, across operation modes. Research[14,15,16] indicates that to assure competence over time organisations must develop assessment methods that can be used for initial and on-going assessments that are not only matched to the mode of operation but also the type of competencies that are being assessed.

Advanced competence management aimed at supporting high reliability operations[17] looks to move beyond judgements of "competent" or "not competent", instead introducing further judgement categories such as 'expert' and 'proficient'. This helps to create a culture of learning and communicates to CROs that the organisation does not just want to see minimum levels of competence but wishes to help CROs strive for excellence. Moreover, to support high reliability operations the frequency and method of assessments should remain flexible to allow for changes in equipment, working practices etc, coupled with the development of assessment methods that can be administered at local sites or centrally at headquarters or main operating sites to help increase consistency of assessments across complex organisations.

The guide explores these concepts in more detail as well as presenting a set of best practice principles drawn from research across high hazard industries[18,19].

Review

The first part of this element is focused on ensuring that competence arrangements deliver CROs with the right technical and non technical competencies. The review must be accurate, identify valid areas of improvement and ensure CRO competence management arrangements are focused on helping to control major accident hazards. Moreover, low rates of operational incidents and reports of good CRO performance does not mean that CRO competence management arrangements should not be reviewed[20]. Instead the frequency of review should be risk based and targeted with greater frequency to areas of concern; structured against clearly defined criteria, mapped to major accident hazards, utilising multiple sources of information including on the job performance, training and assessment results, lessons learnt from accidents, incidents, injuries, near misses, process upset conditions etc, within the organisation and from wider industry.

The guide sets out critical review elements, along with the type of evidence to review for each element. Guidance is also provided to help organisations communicate and act on review findings as well as assess the effectiveness of the review process.

The second part of this element is focused on how organisations can put in place the required supporting arrangements so that the CROs can demonstrate their competence and complete their tasks safely, reliably and efficiently. Evidence suggests a number of factors can affect the demonstration and retention of competence, which in turn can have significant impact on the control of major accident hazards and performance.[21] Critical support arrangements relevant for CROs include:

- Leaders to ensure that CRO competence management is an integral part of the organisation's safety management system and a critical element of safety culture.
- Supervision and management to ensure CROs understand their role, are mentored and coached and provided with opportunities for ongoing competence development.
- Procedures that are clear up-to-date and achievable with the content, level of detail and structure that is based on the task type, criticality, frequency and complexity of the task and knowledge & skills required.
- Control room design that helps control room operators form a clear and holistic mental picture of plant and processes and maintain a good understanding of plant/process status.

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14 Danielsen, B. & Stene, T. (2013). Control room operations and certification for space operations. In Safety, Reliability and Risk Analysis. Beyond the Horizon. Editors: Steenbergen, R., Van Gelder, P., Miraglia, S. & Vrouwenvelder, A CRC Press

15 Manca, D., Nazir, S., & Colombo, S. (2012). Performance indicators for training assessment of control-room operators. Chemical Engineering Transactions. Vol 26. The Italian Association of Chemical Engineering

16 Greenstreet Berman Ltd. (2003) Competence assessment for the hazardous industries. Health and Safety Executive Research Report 086

17 See 11

18 Cogent & United Kingdom Petroleum Industry Association Limited. (2011). Guidelines for Competency Management Systems for Downstream and Petroleum Sites

19 Eurocontrol. (2005). Guidelines for Competence Assessment. European Air Traffic Management Programme. Edition 2

20 Rail Safety and Standards Board. (2013). Good practice guide on competence development. Document No RS/100 issue 1

21 Rail Safety and Standards Board (2012) Good practice guide: Competence retention. T717. A model for competence retention in rail industry (skill fade)

- Management of change process where any change that has the potential to affect the CRO tasks, their competence requirements and/or the processes in place to manage CRO competence triggers a review of the CRO competence management system.

Guidance is provided for each of these elements with a focus on helping organisations understand the impact of these arrangements and how they can be enhanced to support CRO performance and help control major accident hazards.

Assuring CRO competence for routine, infrequent, abnormal and emergency response tasks

Findings from the user requirements workshop, consistent with evidence[22,23], suggests that it can be a significant challenge for organisations to identify, develop and assure plant specific CRO competence across:

- Routine tasks - those that are carried out by the CRO frequently, often on a day to day basis, under normal operating conditions, such as: operating control room under normal conditions, monitoring process and product flows, administration, issuing permits to work and communication with people inside and outside of the control room.
- Infrequent tasks - those tasks that are carried out occasionally by the CRO and in some cases CROs may not have had the opportunity to carry out these tasks within a live operating environment. Examples might include: co-ordinating plant shut down and start up, isolation of critical equipment and components for testing, initiating shut and start ups of critical assets & equipment, monitoring critical systems during these types of activities, monitoring pressure flows and warnings during start up, shut down or isolation of equipment, monitoring interconnected systems, communication with personnel inside and outside the control room during completion of these types of activity.
- Abnormal tasks – tasks carried out during conditions that are outside of normal/expected operating parameters. This could include: using SCADA displays to identify faults, using schematics to diagnose faults, initiation of relevant alarms, isolation of relevant components, computerised operation of values to manage product flow, communication to relevant managers, ongoing observation of process flows and/or system status.
- Emergency response tasks – tasks carried out in any situation where there is a significant threat to life, environment, and/or plant/equipment. These might include identifying and diagnosing critical conditions, activating relevant alarms, reporting critical situation, initiating emergency procedures, including isolations, fail safes and shut down, coordinating between people and safety critical communications.

This is because these tasks differ in terms of: complexity; criticality; frequency of performance; technical and non technical competencies required; sources of information to identify and validate these competencies; types of training and assessment methods; opportunities for training and assessment; requirements for re-assessment, refresher training and depth of initial and on-going training and assessment. For example, for routine tasks there is significant opportunity for on the job training and observation, providing regular opportunities for assessment and on the job coaching. For abnormal condition tasks, as they occur less frequently and are unpredictable and potentially high risk, structured simulated environments, coupled with interactive scenario based learning and coaching are likely to be required, with an increased level of frequency and detail to assure competence.

To help organisations overcome this challenge and support the application of SMARTAR, the guide provides detailed examples of the technical competencies and non technical, cognitive and procedural competencies, CROs require to successfully undertake routine, infrequent, abnormal and emergency response tasks.

Example technical competencies include understanding of expected operating capacity, product pressure flows, temperatures, tolerance and limits during different modes of operations and major accident hazard being controlled by control room operations, Connectivity and dependency of relevant engineering systems & processes. Example non technical, cognitive and procedural competencies include interpretation and prioritisation of information, pattern recognition, dynamic situational awareness, risk based decision making and understanding of the major accident hazard controlled by operating procedures. Sources of information to help identify and validate these competencies and example training needs to help inform initial and on-going training and assessment across these modes of operation are also provided.

Moreover, for each mode of operation, example methods for developing, assessing and assuring these CRO competencies are provided, along with key advantages and disadvantages. The methods are underpinned by the psychological principles of adult learning and include interactive classroom training and toolbox talks using videos, pictures and case studies, dynamic simulator and scenario simulation training and assessment, just in time training and assessment, structured job rotation and on the job training, scenario and case study based knowledge and skill assessments.

Finally, example technical and non technical competencies for trainers and assessors are also provided, such as training and assessment, coaching and managerial skills along with methods for developing and assessing these competencies, such as scenario based train the trainer sessions, peer mentoring and observation, on the job coaching and assessment.

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22 Wright, M., Berman, J. & Turner, D. (2003). Competence assessment and major accident prevention. Institution of Chemical Engineers, Symposium Series No.149

23 See 20

The aim is to help organisations understand and identify: CRO competencies to develop and assess; types of approaches to develop, assess and assure these competencies; competencies trainers and assessors required and the methods that can be used to assure trainer and assessors have acquired and can demonstrate these competencies.

Case studies, job aids and self assessments

Over 20 short case studies are provided within the guide to help illustrate how the SMARTAR model and the principles it enshrines can and have been applied within industry. Case studies are provided for each element of SMARTAR, covering routine, infrequent, abnormal and emergency response tasks. To facilitate the sharing of best practice across industries, the case studies are taken from a range of high hazard sectors, including UK Fire and Rescue Service, Oil and Gas, Nuclear, Aerospace, Rail and Aviation. To further support implementation of the guidance, a set of job aids are provided. Job aids take the form of checklists, for building on standards, utilising principles of adult learning to inform CRO training and assessments as well as aide memoires for using psychological techniques such as Repertory Grid and Critical Incident Technique to validate and enhance training and assessment.

Two self assessments are also provided within the guide, both using a 'traffic light' system to score question answers – yellow and red indicate areas for consideration, while green indicates areas that should be continued and fully supported. The first self assessment aims to help the reader think about the challenges they face ensuring the competence of CROs; identify those that are of most interest/concern, and locate relevant sections of this guide. The second self assessment provides example criteria for reviewing CRO competence management arrangements and allows the reader to assess themselves against this criterion.

Intended use and potential benefits

The guide is an Energy Institute publication, for anyone who wants to find out more about how to ensure the competence of control room operators (CROs). It is for everyone who has responsibility for ensuring the competence of control room operators, for example: production managers & supervisors who manage CROs; members of training departments with responsibility for CRO training and development; internal auditors with responsibility for auditing CRO competence and/or competence management arrangements; CROs themselves to support their personal development; any individual who is involved in the development and assessment of CROs; and directors and senior managers with responsibility for safety management systems and safety cases.

The application of the guide is intended to bring the following potential benefits to organisations:

- Correct determination of CRO competencies required for the prevention of major accident hazards.
- Development and delivery of effective training to ensure that CROs are trained in the right competencies.
- Development and delivery of initial and on-going competence assessment to ensure robust competence assurance for CROs.
- Strengthen organisational arrangements that contribute to safe and reliable CRO performance.
- Competent CROs who are able to carry out their tasks safely and reliably, contributing to the effective control of major accident hazards and the enhancement of plant efficiency.

Conclusions

The "Guidance on ensuring control room operator competence" is structured around the SMARTAR model and provides a tailored approach to help organisations tackle competence management and assurance challenges that are specific to control room operators and the critical role they play in the control of major accident hazards and plant efficiency.

It is comprehensive, written in a straightforward way and provides practical support to organisations through illustrative examples, job aids, self assessments, example technical competencies, non technical, cognitive and procedural competencies, training and assessment approaches across modes of operation.

The guide is underpinned by best practice, standards and research in CRO competence management from across safety critical industries. It is informed by the needs of industry, and being peer reviewed and validated by industry experts and the Energy Institute's HOFCOM to ensure suitability for use in the Energy Sector and any other sector that relies on the competence of control room operators to help control major accident hazards.