

Guidance on ensuring control room operator (CRO) competence

GUIDANCE ON ENSURING CONTROL ROOM OPERATOR (CRO) COMPETENCE

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FOREWORD

Control room operators (CROs) perform a critical role in running normal operations, infrequent activities such as process shut downs, and handling abnormal events and emergencies. Ensuring a sufficient number of competent CROs are available on site is a key element of safety, and can contribute positively to productivity. CROs include people who work fulltime in control rooms, people who have an occasional control room role and control room supervisors or technicians who may need to engage with CROs in specific circumstances.

There are many guides and standards on competence management in safety critical industries. However, this publication provides specific guidance on how to assure competence of CROs in the energy industries, particularly how to define competence standards, select training and development methods, assess CROs and maintain their competence once in post. The guidance is consistent with common models of competence management, but offers guidance that is specific to CROs.

Feedback from industry indicates that there are some particular issues with respect to CROs. There are challenges in achieving an adequate pool of candidates from which to select CROs and challenges in retaining CROs once they are in post. Therefore, this guide goes beyond common competence management guidance to cover these important challenges.

CROs are often selected from field operators, drawing on their experience and knowledge of the plant. This has a major implication; the recruitment of field operators should foresee the subsequent requirement for CROs. This guide therefore advises that at least some field operators are recruited based on their potential to be CROs. Methods of assessing underpinning skills are cited in the guide to help identify potential CROs amongst current or candidate field operators. Given that people do not become established CROs overnight, an incremental approach to competence development is needed, progressing from beginners to established and then to advanced CROs. Guidance is provided on the formulation of an incremental approach to development, combining taught and structured on the job learning.

There are many aspects of retaining people. This guide firstly focuses on providing CROs with a structured route for advancement, providing people with the scope for further development once they are in post. Learning and further qualification opportunities may be provided and CROs encouraged and enabled to make use of these opportunities. In addition, creating a positive working environment through practical procedures, ergonomic equipment, supportive supervision and change management all contribute to staff retention as well as help reduce operator error.

This guide presents a full lifecycle view of CROs, from the creation of a pool of candidates to advancement of their competence when in post. Extensive annexes provide practical tools, such as checklists for assessing the organisation's arrangements for managing CRO competence, job aids for identifying CRO competencies, as well as example CRO competencies (and methods for training and assessment of those competencies) for routine, infrequent, abnormal and routine operations.

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1 INTRODUCTION

1.1 SCOPE

This guide was developed to help address specific challenges relating to the competence management of control room operators (CROs). The guide is focused on the challenges (described in 2.4), identified by industry through a user requirements workshop held 16 July 2013 in London, and aims to help organisations:

- anticipate the need for CROs when selecting the personnel from which future CROs will be selected;
- correctly determine the competencies CROs require to help prevent major accident hazards;
- train CROs in the right competencies;
- ensure a robust competence assurance system for CROs is in place; and
- strengthen organisational arrangements to support and retain CROs.

The guide covers routine, infrequent, abnormal and emergency response tasks, is focused on optimising and assuring CRO competence and briefly covers arrangements such as procedures, supervision, and control room design that support CRO performance. Case study examples, taken from a range of major hazard industries, and sources of further reading, are also provided.

1.2 WHO IS THIS GUIDE FOR?

This guide is for everyone who has responsibility for ensuring the competence of control room operators. Table 1 details which sections of the guide are most relevant for various occupational roles.

The guide has been developed for organisations operating in the energy industry, both onshore and offshore, and applies to both new and existing installations.

Table 1: Sections of guidance most relevant to various occupational roles

Occupational role	Sections of relevance
Managers and supervisors of CROs	2: Setting the scene 3: Stages of CRO development 4: Determine CRO competence requirements 6: Assess CROs 7: Retain and support CROs
Relevant members of training, human resources, learning and development, talent management functions, for example, responsible for CRO training and assessment	2: Setting the scene 3: Stages of CRO development 4: Determine CRO competence requirements 5: Train CROs 6: Assess CROs
Relevant members of health, safety, environment and quality (HSEQ) who influence and/or monitor CRO operations	2: Setting the scene 7: Retain and support CROs 8: Monitor and review CRO competence management arrangements
Internal auditors responsible for auditing CRO competence and/or competence management arrangements	2: Setting the scene 8: Monitor and review CRO competence management arrangements
Directors and senior managers responsible for safety management systems and safety cases	All sections of this guide will be of interest

2 SETTING THE SCENE

2.1 WHO IS THE CRO?

The CRO is at the heart of operations and is the key human element in the process control system. The CRO is the individual interfacing with the plant within the control room, who has direct responsibility (hands-on control) for control room operations. This includes main control rooms, satellite/remote control rooms, local control rooms and field control stations, whether in new or existing installations.

CROs can also include:

- Supervisors, who as part of their role have direct responsibility for controlling operations from the control room.
- Field operators, who may need to be familiar with control room operations, in case the main control room is disabled and there is a requirement for them to operate local/remote control rooms.
- Temporary and permanent control room operators. Staffing levels and the roles and responsibilities of CROs vary by site, meaning that permanent control room operators may not always be in place.

2.2 WHAT IS COMPETENCE MANAGEMENT?

2.2.1 Competence

Competence can be defined as 'the ability to undertake responsibilities and perform activities to a relevant standard, as necessary to ensure process safety and prevent major accidents. Competence is a combination of knowledge, skills and experience and requires a willingness and reliability that work activities will be undertaken in accordance with agreed standards, rules and procedures' (HSE, *COMAH Competent Authority, Inspection of competence management systems at COMAH establishments. Operational delivery guide*).

Competence is commonly broken down into three aspects (RSSB, *Good practice guide on competence development*):

- Knowledge: the underpinning knowledge that a CRO requires to be able to effectively carry out control room operator tasks. This might include knowledge of:
 - control room systems;
 - production processes and chemical reactions, and
 - engineering systems, safe guides and operating procedures, etc.
- Technical skills: the functional skills required to complete control room operator tasks. This might include:
 - physical operation of control room controls and devices to access system status information and relevant schematics, and
 - writing permits to work and recording relevant control room operational information during shift, handover and administration.
- Non-technical skills: the cognitive and behavioural skills required to complete control room operator tasks. This might include:
 - prioritisation of control room process information and decision making during completion of routine control room tasks;
 - communication and teamwork, and
 - willingness to respond to emergencies.

2.2.2 Competence management

Competence management can be defined as 'arrangements to control, in a logical and integrated manner, a cycle of activities within the organisation that will assure, and develop, competent performance. The aim is to ensure that individuals are clear about the performance that is expected of them, that they have received appropriate training, development and assessment, and that they maintain, or develop, their competence over time' (HSE, *COMAH Competent Authority, Inspection of competence management systems at COMAH establishments. Operational delivery guide*). Typical models and approaches to competence management can be found in Annex A.

2.3 WHY DO WE NEED COMPETENT CROs?

Competent CROs provide a number of benefits:

- **Process safety and operational efficiency**
Competent CROs have improved diagnostic accuracy, speed and process control operation (Kluge and Burkolter, 2008). For example, '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' (Larson, 2012).
- **Cost savings**
Effective training can help reduce plant damage, increase plant availability and reduce training costs. This is estimated at roughly \$4,500 per megawatt of generating capacity per year by the Electric Power Research Institute (Ibid.).
- **Compliance improvements**
Competent CROs have greater knowledge of process safety risks, procedures and why they need to be followed. This means they are more likely to support and comply with them.
- **Increased participation in safety**
Increased competence and understanding of process and risk means that individuals start to take greater responsibility for safety, increasing participation in safety initiatives.

2.4 CHALLENGES ENSURING THE COMPETENCE OF CROs

A key challenge for an organisation is how to recruit and retain competent CROs in a timely and cost effective manner. Ensuring the competence of CROs starts when recruiting the operators (from whom CROs may be subsequently selected), proceeds via their training and assessment, and continues throughout their time in post.

Annex C provides self-assessment checklists to help the organisation assess how well these challenges are currently being managed.

2.4.1 Having a suitable pool of candidates

CROs are often selected from field operators. However, field operators may be recruited on the basis of their ability to be field operators rather than anticipating their future potential to be CROs. This can impact the availability of suitable CRO candidates. The challenge for organisations is how to cater for the need for CROs when recruiting field operators.

2.4.2 Using CRO standards

The CRO skill set is a combination of generic and plant specific skills and knowledge. The challenge for organisations is how to build on industry CRO standards and training to develop both generic and site-specific CRO skills and knowledge.

2.4.3 Developing potential CROs

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. This process can also be costly if the initial assessment of a candidate's potential is inadequate and subsequent training does not develop the right competencies. The process should also ensure that potential CROs are not fast-tracked too quickly.

2.4.4 Training, assessment and assurance of CRO competence

CROs' workload and shift patterns mean organisations should optimise different training approaches to train and assess competence. This optimisation relies on the competence of the trainers and assessors. The challenge for any organisation is how to ensure CROs, trainers and assessors acquire the right competencies and can demonstrate these over time.

2.4.5 Retention of CROs

Retention of CROs can also be a significant and costly challenge, as talented CROs may be tempted to move to other organisations. CROs should be provided with incentives to remain in post. This guide focuses on competence issues, such as how to enable further career development of CROs once in post.

2.4.6 Supporting CRO competence and responding to change

Organisations should have appropriate organisational arrangements to help support and retain CROs as well as manage knowledge that can be lost when CROs move roles. Practical procedures, an ergonomic work environment and supportive supervision are all part of the challenge. Organisations should also understand the impact change can have on CRO competence requirements, and review such requirements, when change occurs.

2.5 HOW DOES THIS GUIDE HELP TO ADDRESS THESE CHALLENGES?

This guide is structured around the competence management model illustrated in Figure 1 and adopts a CRO life cycle perspective, starting from ensuring a pool of CRO candidates exists, as outlined in section 3. This structure has been chosen because it:

- a) Illustrates success factors for managing CRO competence that help address the challenges identified by industry.
- b) Follows a logical approach, starting with understanding CRO competence requirements, training and assessing CROs, through to retaining and supporting CROs once in post.
- c) Aligns to a number of common approaches to competence management that are relevant to petroleum and allied industries, such as:

- HSE, *COMAH Competent Authority, Inspection of competence management systems at COMAH establishments. Operational delivery guide*;
- Cogent / UKPIA, *Guidelines for competency management systems for downstream and petroleum sites*;
- EI *Guidance on meeting expectations of EI Process safety management framework Element 3: Employee selection, placement and competency, and health assurance*, and
- CRR 348/2001 *Assessing the safety of staffing arrangements for process operations in the chemical and allied industries*.

Additional models of competence management are referenced in Annex A. A description of the model's five elements is provided in Table 2.

Within sections 4 – 6, the guide aligns training and assessment to stages in the CRO life cycle.

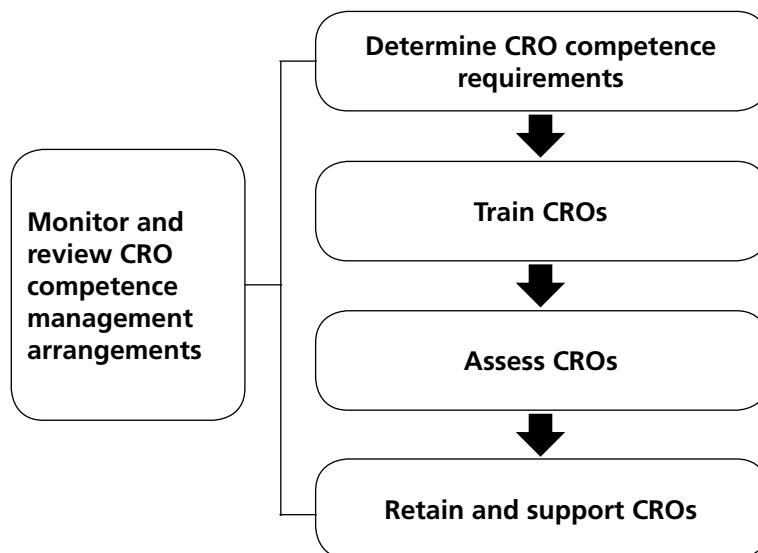


Figure 1: CRO competence management model

Table 2: Description of the CRO competence management model elements

Element	Description
Determine CRO competence requirements (section 4)	This element focuses on identifying the right knowledge, technical and non-technical skills for CROs, matched and prioritised according to major hazard risk and the development stages of CROs. This includes building upon CRO standards and regulations.
Train CROs (section 5)	This element focuses on approaches that can be used to train CROs, including linking training approaches to development stages, psychological principles for adult learning and trainer competence.

Table 2: Description of the CRO competence management model elements (continued)

Element	Description
Assess CROs (section 6)	This element firstly focuses on the assessment of underpinning skills and attitudes requisite for becoming a CRO and commencing training. Secondly, the element focuses on approaches to assess beginner- to advanced- CROs and includes assessor competence.
Retain and support CROs (section 7)	This element focuses on how organisations can enhance retention through supporting CROs.
Monitor and review CRO competence management arrangements (section 8)	This element focuses on approaches and evidence that can be used to monitor and review CRO competence arrangements.

3 STAGES OF CRO DEVELOPMENT

3.1 A DEVELOPMENT LADDER

As people do not become established CROs immediately upon selection, a progressive set of development stages can be applied. A development ladder (Figure 2) illustrates different development stages and example competencies that can be developed at each stage (Buckley and Caple, 2004):

- **'Beginner'** refers to a field operator (for example), who is developing knowledge of control room operations whilst still working as a field operator.
- **'Developing'** refers to an advanced field operator (for example), who has developed the knowledge, technical and non-technical skill to be able to take control of routine operations under supervision.
- **'Established'** refers to a qualified CRO, who can take responsibility for all control room operations independently.
- **'Advanced'** refers to a qualified CRO who has developed technical and non-technical skills to carry out some supervision duties. This stage has been included to highlight how development can be continued after the individual has been selected for the role of CRO.

To provide a structured approach to competence development, the competence requirements for each development stage should be determined, with training and assessments mapped to these development stages. This can help to assure CROs have obtained and can continually demonstrate the necessary knowledge, technical and non-technical skills required to undertake their duties competently and safely.

Guidance on: determining the competence requirements for each development stage can be found in section 4; mapping training approaches to development stages can be found in section 5; and mapping assessment approaches to development stages can be found in section 6.

Example competencies	Description
Planning and allocating work for the team and monitoring the team's performance. Coordinating emergencies and making risk based decisions under abnormal and emergency response conditions. Ensuring and challenging compliance procedures.	Qualified CRO with knowledge, technical and non-technical skills to undertake supervision duties and lead a small team of CROs as well as carry out expected CRO duties.
Monitoring and maintaining health, environment and safety management systems relating to control operations, coordinating handovers and maintaining relationships with site personnel. Maintaining state of readiness and controlling critical situations, responding to emergencies including detection, diagnosis, communications and evacuations.	Qualified CRO with knowledge, technical and non-technical skills developed to take responsibility for all control room operations independently.
Accessing and interpreting equipment and system status, including detection of process upsets and understanding process to restore operations. Unit-wide knowledge including knowledge of emergency systems e.g. plant flare/vent systems, their operation and implication. Communications with site personnel, and situational awareness in routine operations.	Advanced field operator, with technical and non-technical skills developed to take responsibility for routine control room operations and support other modes of operation (under supervision).
Knowledge of plant operating capacity, safe operating limits/envelope and composition of plant product properties. Knowledge of operating instructions and risks they control and ability to interpret basic control room information.	Field operator, with knowledge developed to understand control room operations and plant functioning. Not allowed to carry out duties in control room.

Figure 2: Development ladder

3.2 CASE STUDIES

Case study 1: CRO apprenticeship scheme

A large oil and gas company runs a CRO apprenticeship scheme. This has 15 units to be passed, that are linked to a set of development 'milestones'. The scheme lasts three years and utilises a range of training methods. This includes classroom training providing basic engineering principles, operating instructions and other safety management information, job rotation outside the control room to help individuals understand plant processes, and the effect control room operations have on these processes and safe systems of work. On-the-job training and job rotation within the control room is also provided so individuals understand and develop the competencies to undertake different tasks and roles within the control room.

Simulator training and desktop exercises are also used to help CROs develop and practise the skills required to respond to abnormal and emergency conditions.

Case study 2: 'Pipeline' talent management process

A large nuclear facility has developed a talent management process called 'Pipeline'. The aim of the process is to take beginner recruits and train them into established CROs and then up to Shift Manager. Development milestones through Pipeline have been created, with competencies detailed that must be acquired and demonstrated to achieve that milestone. A set of training modules are delivered for each milestone. Desktop exercises are used to support training and form the basis for assessments. Individuals progress to the next milestone only after all relevant training is undertaken and assessments passed.

Case study 3: Module training for new starters

A rail company has implemented a 12-month module based training programme to help CROs progress from beginner to established. The programme has modules that are focused on the development and application of knowledge and skills such as operation capacity, operating instructions and procedures, emergency procedures, alarm response and management, functional skills and relevant mandatory industry training and health and safety training.

Another set of modules are focused on non-technical skills such as communication, situational awareness, decision making, interpretation, diagnosis and assimilation of information, time management and interpersonal skills. A final set of modules is focused on basic line management, such as enforcing procedures, human factors training, coaching and project management.

4 DETERMINE CRO COMPETENCE REQUIREMENTS

A validated specification of CRO competencies, linked to the stages of development (beginner to advanced), should underpin all elements of CRO competence management. It can inform the assessment of potential CROs (see 6.1), directs the content of training (see section 5) and assessment (see 6.2) and further in-post development of CROs (see section 7). In this way, determining CRO competencies is a prerequisite for all aspects of CRO competence management.

This section focuses on helping to ensure the right knowledge, technical and non-technical skills are identified for CROs. It covers:

- how to determine critical tasks;
- approaches to identifying CRO competencies;
- developing measurable standards of performance, and
- using national and international standards and regulations.

4.1 DETERMINE CRITICAL TASKS

Critical tasks can be defined as 'Those [tasks] that have the potential, if not undertaken correctly, to initiate, propagate or exacerbate a major accident' (HSE, *COMAH Competent Authority, Inspection of competence management systems at COMAH establishments. Operational delivery guide*). Critical tasks should be identified for:

- **Normal operations**
Critical tasks that are carried out by the CRO frequently, often on a day-to-day basis, under normal operating conditions. This might include: operating the 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 operations**
Critical tasks that are carried out occasionally by the CRO. In some cases CROs may not have had the opportunity to carry out these tasks within a live operating environment, but would be expected to complete them if required. Examples might include: coordinating plant shut-down and start-up; isolation of critical equipment and components for testing; initiating shut-downs and start-ups of critical assets and equipment.
- **Abnormal conditions**
Conditions that are outside of normal/expected operating parameters, such as a potential loss of process control or a failure of equipment or monitoring systems. Abnormal condition tasks might include: using supervisory control and data acquisition (SCADA) displays to identify faults; initiation of relevant alarms; computerised operation of valves to manage product flow.
- **Emergency situations**
Any situation where there is a significant threat to life, environment, and/or plant/equipment. This may include a significant loss of process control and/or fire or gas release. Critical tasks during emergency response might include: identifying and diagnosing critical conditions; activating relevant alarms; reporting critical situations; initiating emergency procedures, including isolations, fail safes and shut-down; coordinating between people and critical communications.

For each of these, it may also be helpful to consider:

- the process/operation being undertaken, such as batch or continuous operations;
- any relevant supervision/team leader duties that may be critical for the control of major accident hazards, and
- the complexity of tasks and how often they are performed.

El *Guidance on human factors safety critical task analysis* can be used to help determine CRO critical tasks.

Once the critical tasks have been identified, they should be validated. For example, task analyses can be compared to risk assessments described within the safety case to ensure all relevant major accident hazards and associated CRO tasks have been considered and identified.

4.2 IDENTIFY CRO COMPETENCIES

CRO critical tasks should be analysed to identify the relevant knowledge, technical and non-technical skills required to carry out the tasks reliably and safely. These can then be used as technical and/or non-technical 'markers' for CRO competence assessments.

To help analyse the tasks, the following should be considered:

1. Does the task require generic and/or plant-specific knowledge and skill? For example:
 - Generic knowledge of plant operations and chemical processes, basic engineering, knowledge of complex plant, HSE regulations for COMAH sites etc.
 - Site-specific knowledge of plant layout and connective systems, process control functions, etc.
 - Specific task type knowledge, for example, testing of fire and gas control systems, diagnosis and drill down of schematics during upset conditions.
2. What technical knowledge and skills are required to undertake the task? For example:
 - Knowledge and operation of critical systems, for example, plant flare/vent systems, plant blow-down systems.
 - Understanding the limitations of these systems.
 - Knowledge of plant operating capacity, limits and composition of plant product properties.
3. What non-technical skills are required? For example:
 - Interpreting information on equipment and system status.
 - Communications during handover.
 - Prioritisation and navigation of information.

Job analysis techniques can be used to support this analysis (Doyle, 2003). These techniques should be supported by:

- Information gathered from reviewing relevant procedures.
- Observations and structured talk/walk-throughs of CROs carrying out tasks within the control room or within a simulation/simulated scenario.
- Review of safety case risk assessments and major accident scenarios. This can help ensure all relevant technical and non-technical skills and knowledge have been accurately identified.

1 Markers are examples of skills, knowledge, attitudes and behaviours that are required of people.

Annex D provides job aids to help identify core CRO competencies. Annexes E, F, G and H provide example generic knowledge and skills for routine, infrequent, abnormal and emergency tasks, along with training and assessment methods.

4.2.1 Map competencies to CRO development stages

Whilst a common set of competencies might be determined, the type of competencies to develop and assess may vary across the development stages. For example:

- Beginner CRO competencies may focus on underpinning knowledge requirements, i.e. understanding the plant, role of control room operations and the CRO, rather than the skills required to handle routine operations.
- Developing CRO competencies may additionally focus on the technical and non-technical skills required to handle routine operations, under supervision.
- Established CRO competencies may additionally focus on the technical and non-technical skills to handle infrequent, abnormal and emergency operations, without requiring supervisor guidance.
- Advanced CRO competencies may additionally cover the technical and non-technical skills required to supervise CROs, manage complex infrequent activities such as shut-downs, plan complex work schedules and potentially train and assess CRO competence.

All CRO competencies should be determined first and then segmented and defined per CRO development stage. Once all relevant knowledge, technical and non-technical skills have been defined, they can be prioritised to help inform the frequency and depth of training and assessment required. This may be done by asking CROs, their supervisors and other relevant subject matter experts to rank the importance of each knowledge and skill for successful task completion.

4.3 CREATE MEASURABLE PERFORMANCE STATEMENTS/STANDARDS

Measurable standards of performance describe 'competent' CRO performance for each critical task. They can be used as learning objectives for CRO training and criteria for CRO competence assessments (HSE, *Competence assessment for the hazardous industries*). They should reflect the competencies required for each development stage; example measurable statements are given in Table 3.

Table 3: Example measurable competence performance standards

Stage	Example measurable statement
Beginner	Beginner CROs must be able to successfully describe the operating capacity of the plant and the main functions of the control room.
Developing	Developing CROs must be able to successfully access and interpret routine SCADA information, determining and describing current system status.
Established	Established CROs must be able to describe how the fire and gas control system works, be able to detect and interpret the alarms associated with the system and carry out expected control room actions as described in company procedures.

Table 3: Example measurable competence performance standards (continued)

Stage	Example measurable statement
Advanced	Advanced CROs must be able to manage the completion of infrequent operations, such as removing and replacing a hydrocarbon pump, starting from developing the plan of working, specifying permits to work, instructing relevant staff and monitoring relevant control room instrumentation to understand pump integrity and stability before start-up.

Statements should be measurable, in that it is possible to identify a way of either observing the person performing the actions correctly and/or they can verbally state the required knowledge.

Standards often describe the minimum level of competence needed to carry out critical roles. If possible, measurable statements of performance should describe 'competent', 'expert' and 'proficient' performance (RSSB, *Good practice guide on competence development*). This may help to create a culture of learning, and communicates to CROs that the organisation wishes to help CROs strive for excellence.

4.3.1 Utilise national and international standards and regulations

National and international standards and regulations, for example National Occupational Standards (NOSs) and the aforementioned HSE *Inspection of competence management systems at COMAH Establishments*, can be used to help determine CRO competence requirements, creating measurable statements of performance. However, as these are generic, it may be helpful to map site- and plant-specific CRO competencies onto these standards/regulations and identify any gaps.

Table 4 describes three steps that can be followed.

Table 4: Steps to map plant-specific CRO competencies

Steps	Guidance
Step 1: Gap analysis	Compare the CRO activities, requirements, knowledge and skills described in the standard and/or regulation against your identified CRO competence requirements. From this determine: 1. Relevance – Is the standard and/or regulation relevant? Are all areas relevant, or certain parts? Do existing CRO competence frameworks and/or training and assessment programmes already cover the content? 2. Removals – Can areas be removed if they are not relevant? (e.g. modules of a training programme). 3. Additions – Do additional modules/elements need to be created or existing ones revised to meet competence requirements?

Table 4: Steps to map plant-specific CRO competencies (continued)

Steps	Guidance
Step 2: Populate	Based on the gap analysis: 1. Remove, if possible, areas that are irrelevant. 2. Work through each relevant module/element outlined and describe CRO knowledge, technical and non-technical skills that relate to that module/element. Use short, clear statements. 3. Create additional modules/elements. For example, with a National Vocation Qualification (NVQ), additional training modules could be created. When amending and/or creating additional areas, the following should be described: the type of task the CRO will be undertaking (routine, infrequent, abnormal, emergency); the critical tasks the relevant knowledge, technical and non-technical skills required, and grouped (where applicable) per CRO development stage.
Step 3: Review and validate	Where amendments or additional modules have been developed it may be useful to have them reviewed before being implemented. CROs and their supervisors/managers can be asked to review amendments and/or additional modules.

Once reviewed, validated and accepted, it should be planned how the standard and/or relegation will be implemented across the organisation. Table 5 describes a number of areas to consider.

Table 5: Considerations for implementing standards and/or regulations

Areas to consider	Guidance
How will standards/regulations be implemented?	1. Determine how the standard and/or regulation can be incorporated into existing training and assessment programmes, for example: – Can an NVQ or National Skills Academy training course be incorporated into existing talent management arrangements or current CRO training and assessment? – Can a new standard or regulation be turned into an additional training module and incorporated into ongoing CRO training and assessment? – Can existing CRO training and assessment be adjusted to take account of new standards, regulations and any additions developed? 2. Consider the range of training and assessment methods available for implementation (on-the-job, peer assisted, self-directed and simulations) to help reduce the potential workload burden on CROs, trainers and assessors. 3. Identify any additional competencies the trainers and assessors require.

Table 5: Considerations for implementing standards and/or regulations (continued)

Areas to consider	Guidance
What will be the ongoing training and assessment requirements?	1. Determine the type and frequency of ongoing training and assessment. This should be informed by criticality of the CRO tasks, the frequency CRO tasks are performed, and likely degradation of competence over time.
How will the implementation be communicated?	1. Line manager/CRO pre-implementation discussions should take place, covering purpose of the standards and regulations, benefits it will bring the CRO and the business, activities the CRO will be undertaking, timescales for implementation, work demands etc, and support the CRO will receive from the line manager, colleagues and the business. 2. Follow-up discussions should take place throughout implementation (if applicable) to identify any barriers to demonstrating competence and further competence needs. 3. Post-implementation discussions should set out ongoing mentoring and development activities and schedule (if possible and relevant) of ongoing assessments.
How will the implementation be reviewed?	1. Review once implemented. If possible, such as with NVQs, the review can be undertaken throughout the programme to determine whether it is developing the right competencies. 2. Ideally use a combination of CRO feedback, CRO competence assessment and re-assessment, CRO job performance data and reported process upsets, near misses, incidents, accidents etc. related to control room operations and the competence of CROs. 3. The review should help determine if the standard and/or regulation has met CRO competence needs and what improvements can be made.

Annex D provides a job aid to help the organisation make use of relevant standards.

4.4 DEVEOP CRO TASK INVENTORIES

CRO competence requirements can be collated into CRO task inventories, per CRO development stage, and ideally (and where applicable) per operational condition, i.e. normal operations, infrequent tasks, plant upset/abnormal conditions and emergency situations.

An example way of structuring a CRO task inventory for an 'established' CRO, using an example abnormal condition task, is provided in Table 6. CRO task inventories should also contain information on CRO training and assessment requirements. Sections 5 and 6 provide guidance to help determine this information.

Table 6: Established CRO task inventory for abnormal operations (example task)

Critical tasks	Knowledge	Technical skills	Non-technical skill	Statement of competent performance	Training required	Assessments required
Initiating emergency procedures due to leak of hydrocarbon from a storage tank	Knowledge of hazards and operating rules and limits	Physical activation of relevant isolation controls	Information acquisition and assimilation Ability to control stress levels	Individual demonstrates ability to come to a timely decision about emergency response actions Individual remains calm and composed throughout event	Interactive classroom training on knowledge of hazards, operating rules and limits, processes Structured scenario learning, taking individual through each element of emergency management for this event	Verbal or written knowledge assessment covering knowledge of hazards, operating rules, limits, processes Simulated exercise assessing the individual's skills to carry out emergency response management

4.5 CASE STUDIES

Case study 4: Critical tasks and competencies for upset condition and emergency response tasks

A multi-national gas company used critical task analysis and critical incident techniques to identify the competencies required to complete upset condition tasks and emergency response tasks.

Procedures were reviewed, with task analysis used to identify the critical tasks to be completed. Scenario based walk-throughs were then conducted, along with interviews with CROs who had been involved in upset conditions and emergency responses. These were used to help validate the task analysis and start to identify the technical and non-technical skills. A review of near miss, incident and accident reports from within the company and also across the industry were used to help identify competencies, coupled with critical incident interviews with operators.

Based on this information a set of technical and non-technical markers were developed. These were validated through comparing the information to risk assessments completed as part of the safety case. They were also applied to major accident scenarios that were described within the safety case, to validate the markers. Finally operators, supervisors and subject matter specialists were asked to peer review the markers. The markers were used to identify training needs and develop a suite of technical training, non-technical training and assessments that focused on assessing both technical and non-technical knowledge and skill within a scenario/simulated environment.

Case study 5: Using CRO National Occupational Standards (NOSs) to create CRO training

An organisation refining and distributing petroleum used CRO NOSs to create an accredited CRO training programme. The programme awards CROs with an NVQ and then a Foundation Degree. The NOSs were populated with plant/terminal-specific CRO technical and non-technical knowledge and skills. Additional elements were added relating to emergency response procedures, local safe systems of work and specific process controls, roles and operations expected in the control room.

NOSs were collated into a CRO competence framework (meeting Cogent industry-endorsed *Gold standard* competency framework for the process industries). The training programme was structured around each element of the framework. The programme utilises formal training, on-the-job training, and self-directed continuing professional development (CPD), with ongoing assessments matched to task frequency and criticality and role-specific abilities. Trainers and assessors are provided with train the trainer sessions to ensure competence.

The programme is audited externally and internally to understand whether the competence framework is up to date and accurate and if the training is effective.

5 TRAIN CROs

Suitable and effective training, matched to the appropriate stage of development (for example beginner to advanced), can allow CROs to develop the necessary knowledge, technical and non-technical skills required to undertake their role.

This section focuses on providing suitable and effective training to CROs. It covers:

- identifying training needs;
- mapping training approaches to CRO development stages, and
- creating a positive learning environment.

The content and form of training may match the competencies defined per CRO stage, such as:

- introductory training for beginner CROs;
- in-depth training for developing CROs;
- refresher training for established CROs, and
- specialist training for advanced CROs.

The form of training is also likely to be determined by the type of knowledge and skill, task frequency and task difficulty.

It should be noted that a developing CRO may be trained in the competencies for an established CRO once they have been assessed as satisfying the criteria for a developing CRO. Once a person is an established CRO they may need refresher training, especially for infrequent, abnormal and emergency tasks.

Annexes E, F, G and H provide example methods for training CROs for routine, infrequent, abnormal and emergency operations.

5.1 IDENTIFY TRAINING NEEDS

To develop and maintain the skills and knowledge of CROs, training needs should be identified (RSSB, *Risk based training needs analysis. Guide to the process and templates*). This includes mandatory training and qualifications relevant to the tasks, and skills and knowledge needed to complete those tasks.

To help identify CRO training needs, the following should be considered:

- Frequency of performance – how often is the task performed and is the execution of the task observable? e.g. manual tasks vs. decision making.
- Difficulty of task – how difficult is the task to learn and perform competently?
- Skill vs. knowledge – are skills, knowledge, or both being developed?
- Generic vs. site/plant-specific – are generic and/or plant/site-specific knowledge and skill being developed?
- Development stage – what type and duration of experience is required for each stage? For example, a developing CRO may be required to undertake six months' supervised operation of critical routine tasks before being allowed to carry out these tasks independently.
- Current assessments – if applicable, what training needs have been identified from previous competence assessments?

This information may help to determine:

- Type of training, for example: classroom based, on-the-job and/or scenario learning.
- Level/depth of training, for example: a briefing, one-day session or a set of detailed modules.
- Content of training, for example: technical knowledge and/or skill development.
- Type and frequency of refresher training, for example: no refresher training as task is performed daily and is of low difficulty; or on-the-job refresher training every three years, as task is performed regularly and is of medium difficulty; or yearly scenario based refresher training as task is performed infrequently and is difficult to perform.
- Assessment requirements, for example: type, frequency and structure of assessments.
- Trainer/assessor competence, for example: technical understanding of chemical processes and engineering, non-technical skills such as coaching, observation and providing constructive feedback.

5.2 MAP TRAINING TO DEVELOPMENT STAGES

Mapping training to CRO development stages may help develop the correct competencies for each stage (Berger and Berger, 2011). As part of this, relevant qualifications required for each development stage should be identified.

To help CROs progress through the development stages it can be useful to maximise training methods that expose CROs to a range of plant and control room operations. A good way to do this is through modular training, using approaches like on-the-job training, shadowing, observations, scenario exercises and job rotation. These approaches help maximise CRO exposure to plant and control room operations.

Table 7 illustrates example training for the development stages.

Table 7: Example training approaches mapped to development stages

Development stage	Example training
Beginner	– Job rotation of selected field operator roles to develop knowledge of plant operations and activities. On-the-job training structured around developing understanding of how control room operations affect plant operation. – Classroom training focusing on technical understanding of operating instructions. Supported by facilitated scenarios, simulators or simulation of routine operations. Structured self-directed assignments to learn about specific plant operations and control room operations. Structured shadowing and observations of control room operations to understand the basic operations, context and information to interpret.
Developing	– Shadowing of control room operations and job rotation, with structured on-the-job training to undertake routine operations under supervision with targeted coaching. Classroom training focused on non-technical skills to undertake routine operations. Taking part in facilitated scenario-based learning (simulators or simulation) to develop these skills. Structured self-directed assignments to enhance these skills plus any mandatory training required by the organisation or regulator.

Table 7: Example training approaches mapped to development stages (continued)

Development stage	Example training
Established	To reach the 'established' stage further training may focus on: – Shadowing of infrequent tasks and process upset conditions, and job rotation to undertake duties in these conditions, if possible. Simulated or simulation of these conditions focused on allowing the CRO to take full control of operations, reducing and eventually eliminating the requirement for supervision. – Classroom training focusing on advanced non-technical skills, particularly for infrequent, abnormal and emergency response situations. This can include crew resource management (CRM) training, basic safety leadership training, safety behaviour awareness training and risk-based decision making. Also any mandatory training required by the organisation or regulator.
Advanced	– Classroom training focusing on supervision and leadership skills, basic incident command and relevant management training such as Institution of Occupational Safety and Health (IOSH) <i>Managing safely</i>. This should be supported by on-the-job training, focusing on basic supervision. – Scenario-based learning (simulators or simulation) to develop skills in coordinating emergencies and ensuring compliance. This can include shadowing supervisors during these scenarios. Job rotation, to practise allocating and monitoring a small number of tasks performed by a team of CROs. – Any mandatory training required by the organisation or regulator for supervision.

5.3 CREATE A POSITIVE LEARNING ENVIRONMENT

To help create a positive learning environment, CRO training can be designed around psychological principles for adult learning (Jarvis et al, 2003; Krause et al, 2002). These principles are summarised in Figure 3. Annex D provides a job aid detailing the principles of adult learning.



Figure 3: Psychological principles for adult learning

5.3.1 Motivation

Motivation to acquire/refresh knowledge or skills can be fostered by helping CROs understand how training and development will benefit them. To achieve this, training can be selected based on identified training needs, task criticality and the specific competencies to be developed.

Adult learners may resist learning if they feel it is being imposed on them. Fostering individual responsibility for learning may help to motivate CROs and improve the learning experience. One way of achieving this is to create graded CRO learning programmes, meaning that as the CRO moves through a programme, opportunities for self-directed learning increase and direct supervision of them decreases.

Motivation and responsibility for learning can also be fostered through developing group and individual activities requiring CROs to take concepts, theories, and information being taught and generate learning outputs that they then apply in the control room with the support of line managers and peers.

5.3.2 Experience

Experience is a source of an adult's identity. Learning material taught to CROs should be integrated into their own experiences to complement existing knowledge. For example, the frequency of refresher training should be matched to task criticality, difficulty and frequency of performance, demonstrating how training enhances or 'refreshes' CROs' existing knowledge.

CROs should also be provided with reflective learning opportunities, including peer feedback, to help them reflect on how existing knowledge and ways of working can be enhanced.

5.3.3 Learn by doing

CRO training should always involve a high level of practice and application. For example, training can present theory and concepts, and then the use of activities, scenarios, on-the-job training, etc, can provide practice, coupled with constructive feedback. These activities should be set within a context that a CRO can relate to, with a focus on helping them tackle/ solve problems that they commonly face. Table 8 describes some key considerations when developing practical-based learning activities.

Table 8: Considerations for developing practical-based learning activities

Areas to consider	Guidance
Matching practical-based learning to specific training needs.	Identified critical tasks, competencies and measurable statements of performance can be used to structure learning activities as they describe the types of tasks, behaviours, skills, knowledge and performance the CRO is expected to demonstrate during activities.
Covering the range of task types (routine, infrequent, abnormal and emergency response).	Practical-based learning should look to develop both knowledge and skill, either technical and/or non-technical across the activities. As part of this, it is helpful to identify whether the application of the skill/ knowledge can be observed within an activity or whether it will need to be explained/talked through by the CRO.
Making activities realistic and safe.	Any activity/scenario should match task characteristics and operational mode, and provide a safe learning environment. For example, abnormal and emergency response CRO tasks should be mocked-up using dynamic and changing scenarios or desktop activities, whereas routine tasks can more easily be trained within a control room environment using structured on-the-job training.

CROs may also learn better in an informal environment, meaning training opportunities that do not require the CRO to sit in a classroom should be maximised. Adults also like variety in teaching, so it is beneficial to use different training methods. This is sometimes termed 'blended learning' (see Kluge and Burkolter, 2010; IAEA-TECDOC-1411; Kim and Byun, 2011), utilising methods such as multimedia materials, interactive discovery activities, role-plays, mock-ups, case studies, simulations, on-the-job and peer-led teaching, and self-directed and e-learning.

5.3.4 Respect and trust

Adults learn better if they are respected and they trust the trainer (i.e. are confident that the trainer has the necessary skills, knowledge and experience). Respect can be demonstrated through effective facilitation, such as taking an interest in CROs' questions, thoughts and feedback, acknowledging experiences of CROs and the level of experience they have. It is also important to encourage CROs to express ideas, reasoning, thoughts and decisions.