# RISKworld

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Welcome to Issue 26 of RISKworld. If you would like additional copies please contact us, and feel free to pass on RISKworld to other people in your organisation. We would also be pleased to hear any feedback you may have on this issue or suggestions for future editions.

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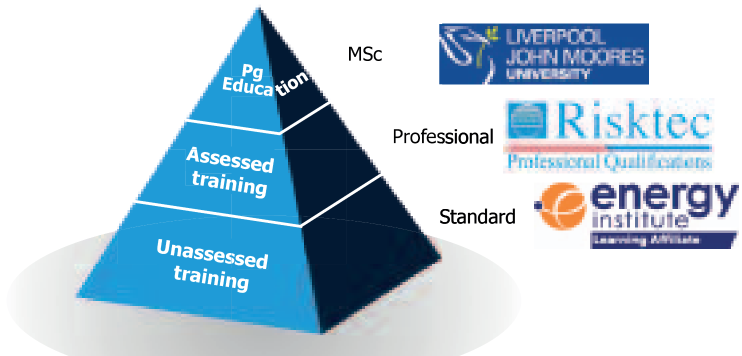
## Risktec Professional Qualifications




**Helping to develop competent risk and safety professionals for industry**

We are pleased to bring you this latest edition of RISKworld, our 26th, which presents articles on a wide range of topics in the risk and safety arena.

Risktec became part of the TÜV Rheinland Group in February this year and has continued to flourish. We opened our first office in **The Netherlands**, near The Hague, earlier this year, to continue our philosophy of operating close to clients in key markets. We have continued to actively recruit other new personnel across Risktec offices to meet the demand from our core markets.

We were also delighted to sign-up the first wave of delegates to our new **Risktec Professional Qualifications (RPQs)** in Risk and Safety Management, complementing our established MSc programmes offered in partnership with Liverpool John Moores University (LJMU) and our attendance-only courses. With these new training programmes we now offer our clients a pyramid of training solutions to meet their needs.

Risk and safety management professionals may now choose to demonstrate both their competence in the field of risk and safety and their commitment to career development with a formal professional qualification from a respected company.

We believe the RPQs to be the world's first such awards designed by professionals for professionals in the major hazard industries. The RPQs combine and condense the collective knowledge of over 50 of our most highly experienced consultants. Studying all 12 modules gains access to around 1800 pages of content, plus 120 online activities designed to reinforce the learner's newly acquired skills.

The **articles in this edition** once again illustrate the considerable challenges facing those working in the safety industry.

Changes in legislation aimed at preventing major accidents, in this instance the recent changes in the European offshore and rail sectors, require detailed consideration and response.

There is an increasing focus on demonstrating competence of personnel working in the safety industry and furthermore, organisations have a responsibility to communicate potential major accident events to a very wide group of stakeholders.

We also discuss how the established and respected bowtie method has been adapted for the emerging Carbon Capture and Storage sector.

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# Bowtie by Numbers – Quantifying Bowtie Diagrams for Carbon Capture

CCS, or Carbon Capture and Storage, is a technology that captures carbon dioxide ($CO_2$) from the burning of coal and gas for power generation or other industrial uses, and transports it by either pipeline or ship for safe and permanent underground storage. The goal is to prevent $CO_2$ from entering the atmosphere and contributing to climate change.

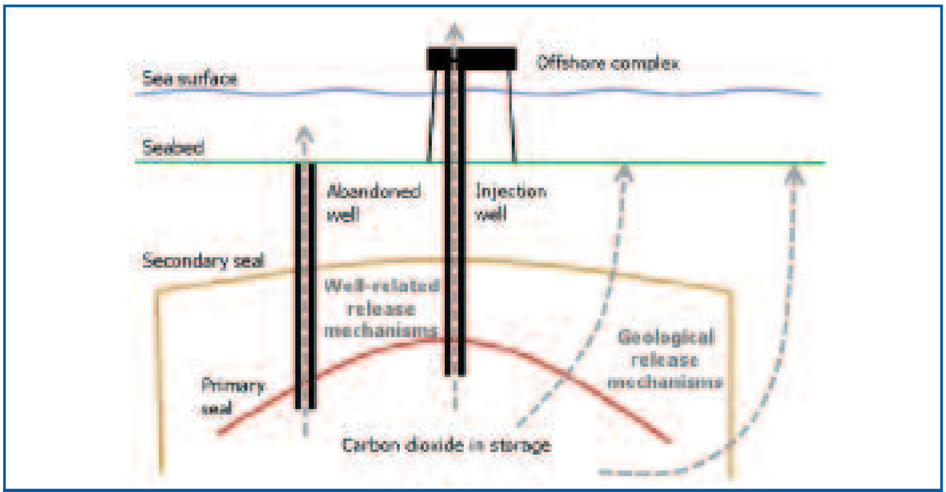


*Fig. 2 - Carbon dioxide release mechanisms from offshore underground storage*

## Bowtie application

Bowtie analysis of the hazards associated with subsurface storage provides a rigorous, easy-to-communicate assessment of the risks associated with failing to contain the $CO_2$, while identifying and examining the barriers in place to prevent leakage as well as the mitigation measures that minimise the consequences of any release, as illustrated in Figure 1.

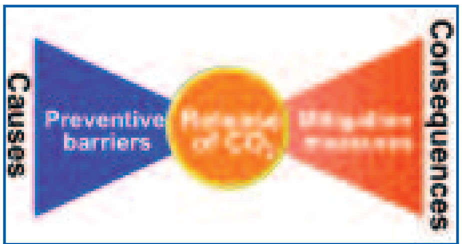


*Fig. 1 - The bowtie diagram*

Quantifying the resulting bowties provides an additional dimension and generates useful inputs to project decisions and plans. The quantitative bowtie model aims to determine which potential $CO_2$ release mechanisms are more likely and assesses the benefit of monitoring activities which may continue for decades into the future.

## Release modelling

Factors that can reduce storage integrity, by weakening the cap rock or creating leak paths that bypass the seal, include acidic fluid action, existing geological faults, stress of injection, diffusion and lateral migration for example. Each release mechanism may be illustrated as a separate bowtie cause, with cause-specific prevention measures such as impermeable geological layers, engineered barriers (e.g. injection well design) and active barriers (e.g. monitoring of $CO_2$ dispersion). Failure of these barriers could result in $CO_2$ release from storage and, if mitigation measures also fail, a range of consequences might arise (e.g. release of $CO_2$ at the seabed, or release into the subsurface above the seal), as depicted in Figure 2.

The resulting bowtie model may be presented as a set of interlinked bowtie diagrams to show the progression of subsurface releases to the surface. To allow the numerical values assigned to the bowtie components to be combined easily, the bowties need to be structured so that cause branches are independent of each other as far as practical and prevention measures for the same cause are also independent.

On the right side of the diagrams, however, not all dependencies can be removed, e.g. mitigation measures involving corrective action are dependent on mitigation measures which detect the $CO_2$ release.

If dependencies are significant, fault trees may be constructed to confirm the mathematical logic of the relationship between bowtie branch frequencies and mitigation measure probabilities of failure, to give overall consequence frequencies.

## Aims of the model

Although intended to be indicative rather than absolute, the frequency of $CO_2$ releases arising from well-related mechanisms predicted by the model may be compared with data available within the CCS and analogous industries to verify the model results align with experience.

One aim of the analysis would be to confirm that the frequency of potentially damaging releases is so low that the individual risk to people offshore is well below the broadly acceptable level of one in a million per year.

A similar objective is to show that the associated risk to the environment from $CO_2$ reaching the seabed is below broadly acceptable levels for the majority of the project life cycle. The model can even help evaluate the risk of damage to reputation, noting that even deep subsurface releases are likely to attract attention from the global media.

## An aid to risk reduction

As well as painting the overall risk picture, the model can be used to identify the biggest contributors to the frequency of $CO_2$ release. Typically, this arises from injection wells until they are plugged and abandoned. After this point, the frequency of release should reduce significantly, and is usually dominated by releases from abandoned exploration and appraisal wells connected to the reservoir.

Moreover, the bowtie model can be used to help identify additional prevention or mitigation measures which have the most benefit in terms of risk reduction.

## Conclusion

Combining traditional, qualitative bowtie analysis with quantification of the bowtie provides an integrated tool capable of evaluating and assessing the risks of $CO_2$ leakage from CCS, whilst also aiding risk reduction decisions. The versatility of the bowtie method in handling the novel and challenging nature of the CCS industry is also demonstrated.

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# The Impact of the EC Offshore Directive on the UK Offshore Safety Case Regime

In June 2013, the European Commission (EC) published the Offshore Directive, which aims to reduce as far as practicable the occurrence of major accidents related to offshore oil and gas operations and limit their consequences. In response to the directive, a draft consultative document was launched in July 2014 by the UK Health and Safety Executive (HSE) and Department of Energy and Climate Change (DECC) setting out the ways that the EC requirements will be incorporated into the existing UK Offshore Safety Case regime (Ref 1).

Although still in the consultation phase, this gives a view of what the future of safety cases may look like, including the new Offshore Safety Case Regulations (OSCR 2015). Some of the key additions and their implications are considered below.

## Corporate Major Accident Prevention Policy (CMAPP)

To ensure that major hazards are fully managed by the controlling organisation there is a new requirement for all operators to have a corporate policy on how major accidents are managed by producing a CMAPP. Although there have been varying views on which part of the business should produce such a policy and whether it only applies to companies registered as corporations, the guidance concludes that all operators in the North Sea should produce a CMAPP.

For many operators the policy should be an extension of existing major hazard management practices at a high level and indeed help reinforce safety leadership from the controlling entity in charge of the operator's UK activities. The HSE consultation suggests additional capital expenditure may be needed, but this could be reduced or absorbed by the current industry drive to develop encompassing Process Safety Management Systems and the increased desire for more visible safety leadership.

## Integration of environmental content in safety cases

The new OSCR 2015 will require the inclusion of environmental assessment, management and emergency response arrangements within safety cases. The manner of integration with existing safety arrangements is still subject to the consultation process, but the use of combined safety and environmental management systems and the adoption of a similar approach for Environmental Critical Element (ECEs) as is currently used for Safety Critical Elements (SCEs) would seem a sensible approach.

The benefits of combining or separating the safety and environmental requirements will depend on the assessment preferences of the Competent Authority (more on that later), as well as operator maturity and desire for a common approach. Whilst the HSE guidance discusses keeping oil spill plans separate and tailoring management systems to operator preferences, there seems to be most synergy in applying a common approach for critical element identification and management.

Certainly, achieving ECE identification and management through a major accident hazard analysis method, such as the preparation of bowtie diagrams, followed by the development of performance standards for the ECEs would provide consistency with the current SCE approach.

## Communicating changes to staff

The HSE consultation states that the changes will have to be communicated to the workforce. This provides an ideal opportunity to increase workforce involvement in developing the safety case and thus help improve 'buy-in'. Furthermore, bespoke safety training focusing on the operator's safety case approach provide an opportunity to engage and promote the new updates to staff.

## Application of the safety case regime to emerging energy technologies

The consultation on OSCR 2015 includes consideration of areas where emerging energy technologies, such as coal gasification or operations such as shale gas exploitation in internal waters (lakes, rivers, estuaries, etc.), may need to be included within the safety case regime.

## A new Competent Authority

Enforcement of the combined environmental and safety requirements of OSCR 2015 will be carried out by a new Competent Authority, formed by the HSE and DECC working together in a similar way to that currently in force for onshore major hazard sites.

## Conclusion

Whilst implementing the EC Offshore Directive in the UK will necessitate additional effort, its impact is evolutionary rather than revolutionary and complements the existing safety case regime.

## Reference


1. Consultation on the implementation of Directive 2013/30/EU on the safety of offshore oil and gas operations..., DECC and HSE, CD272, July 2014



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# Emergency Broadcast – Communicating Major Accident Events

Major Accident Events (MAEs) are low frequency, high consequence events typified by accidents such as Deepwater Horizon, Fukushima and Texas City. Significant efforts are made by operators to prevent and mitigate these events. But how well do we communicate what these events might be and how we would manage them?

Analysis of MAEs is usually undertaken for safety case purposes, and communication materials are typically derived from supporting documentation. However, this information is often quite technical in nature and is intended for a different purpose. As a result, it is common for communication efforts to miss the mark – being overly complex and not engaging the end user. So what is the best approach?

There are many methods and media to communicate MAEs, but before deciding the best approach we really need to answer two basic questions:

- Who are we communicating with?
- What are we communicating?

## Who and what?

Stakeholders with whom communication is needed include regulators, investors, partner companies, company senior managers, the workforce and the public. All of them will want to know that MAEs are properly managed, but they will each want a different breadth, depth and type of information.

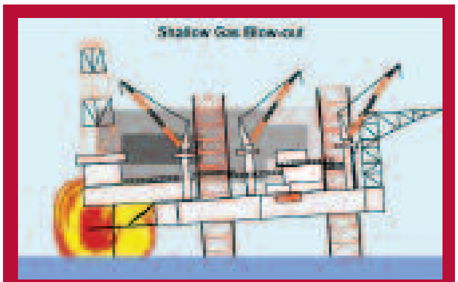
Regulators, for example, may want to see relevant ALARP justification and supporting analysis, whilst others such as senior managers may be more interested in overall risk levels and how much any improvements will cost. Areas of interest to the workforce will include general awareness of the MAEs and their role in prevention and mitigation. In all cases the information must be factually correct to ensure credibility.

## Methods and media – what style of communication is best?

There is no single answer to this question, but it does depend on who and what is being communicated and, as always, budget.

The media that can be used is vast, including reports, leaflets, online, film, presentation and interactive training. The number of methods is also numerous and many can be deployed by multi-media.

A selection of common MAE communication methods include:




**MAE Illustration:**
Showing by cartoon or realistic image what the MAE would look like for a facility.

*Pros* – Pictorial and easy to understand.

*Cons* – Consequence-based only, since it's harder to illustrate frequency; diagram can get cluttered with additional information.

**MAE Risk Overlays:**
Risk contours or heat maps overlaid over a facility drawing or picture to illustrate areas of higher risk.

*Pros* – Colours can convey the level of risk throughout a facility.

*Cons* – Can be a tricky concept for some.

**MAE Awareness Booklets:**
Providing tailored information to the target group, e.g. the workforce or the public.

*Pros* – Can be interesting and provide targeted information.

*Cons* – Often a little dry, especially if information is simply cut and pasted from the safety case.

**MAE Experience:**
Delegates experience real explosions and fires at test facilities, e.g. Spadeadam, UK.

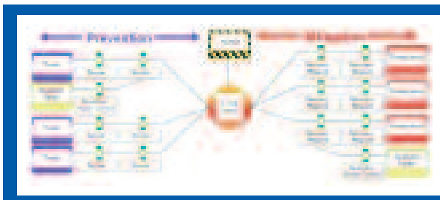
*Pros* – Very engaging.

*Cons* – Not facility specific.

**MAE Games–based Training:**
Games such as Jenga can be used to illustrate MAE concepts like barriers and assurance.

*Pros* – Interactive and engaging.

*Cons* – Few, especially when used with other methods.



**MAE Bowties:**
Showing in greater or lesser detail the barriers in place.

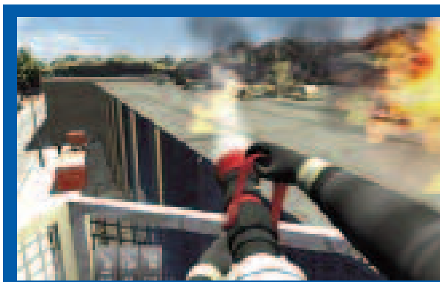
*Pros* – Easily understandable pictorial representation of how each MAE is managed.

*Cons* – Can be large and hard to display.

**MAE Presentation or Film:**
Delivered face to face, online or via TV monitors.

*Pros* – Can be tailored to the target group, and online versions can include comprehension tests.

*Cons* – Can be dry unless genuine creative effort is applied.



**Animated MAE Simulator:**
PC or tablet based with a game feel.

*Pros* – Interactive, engaging and facility specific.

*Cons* – Can be expensive if not properly managed given the huge range of potential scenarios.

There are many other methods available, including consequence overlays, Swiss cheese diagrams, MAE versus control measures matrices, MAE information sheets, wall posters, and MAE safety moments.

## Conclusion

With a little thought you really can communicate awareness of MAEs at the right level to the right people using a media and method to suit them. As Henry Ford once said, "Whether you think you can or you think you can't, you're probably right."

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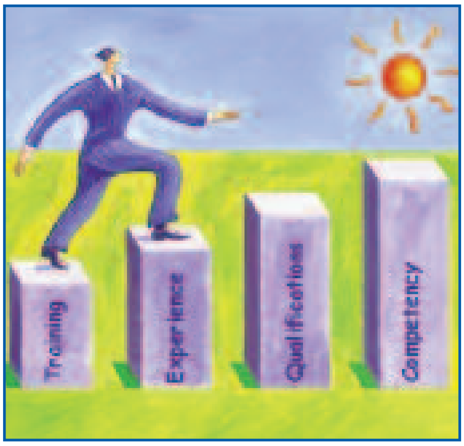
# The Right Stuff – Competency in Process Safety Engineering




The UK Health and Safety Executive (HSE) defines competence as *"the combination of training, skills, experience and knowledge that a person has and their ability to apply them to perform a task safely"*. Whilst organisations are encouraged to ensure and demonstrate that all employees have the necessary competence for their roles, where personnel are involved in safety critical activities this requirement is clearly essential.

For many disciplines, such as mechanical or chemical engineering for example, the professional skills and competencies that need to be met and maintained are generally well defined and governed. However, for those engineers and scientists working in the field of process safety, the required competencies are less well established.

The UK's Institution of Chemical Engineers (IChemE) has perhaps done the most to provide guidance on what this relatively new discipline encompasses. Their new Professional Process Safety Engineer (PPSE) registration provides useful guidance on the key areas of knowledge that need to be demonstrated. Some large oil companies have also worked hard to define and implement similar approaches. However, it is fair to suggest that there is still some way to go in terms of clearly defining what it means to be a competent process safety engineer.

## Organisation-specific approach

One key issue to emphasise is that for any given organisation the particular competencies required for a process safety role should be determined based on an understanding of the specific responsibilities and duties of the individual in that role. It is crucial that the explicit mapping between key responsibilities, activities and tasks, and the individual's defined competencies can be demonstrated, especially for safety critical activities.

Process safety roles with similar titles may also differ substantially between organisations due to company standards, resources and culture. As such the required competencies cannot easily be generalised. For these reasons, the development of role-specific competence profiles is recommended as the best way of ensuring that competence requirements for individual process safety positions are met.

The key steps for providing the basis for a successful process safety competence management system include:

1. Gain a detailed understanding of the tasks that an individual has to undertake, and what successful process safety and operational performance looks like. The relative criticality (safety, operational and, where applicable, environmental) of particular tasks also needs to be understood.
2. Determine the specific knowledge requirements, skills and behaviours that are necessary to support success of each task. Once these elements are identified, then the required competence level for the role needs to be agreed, e.g. from 'awareness', through 'skilled application' to 'expert'.
3. Define an appropriate competence assessment process. Typically, this may need to call upon a number of methods to gather evidence of competence, including structured interviews, direct observations of work activities, use of simulators and training exercises, reviewing work output and seeking feedback from peers.
4. Identify the options available for filling any identified gaps in competence, such as providing more project specific experience, opportunities for on-the-job learning or additional formal training (see Box 1).

## Common competencies

Although process safety competence requirements ideally need to be defined based upon the tasks of the specific roles within the organisation, there are clearly some fundamental areas of competence. These include hazard identification, risk assessment, safety report preparation, process safety performance monitoring and auditing, and incident investigation. furthermore, non-technical skills such as written and verbal communication and teamwork for example, may be as important. Indeed, for senior management roles, they are likely to be more important than technical practitioner experience.

**Box 1 - Training solutions**

Whilst competence is much more than just training, training is nevertheless an important part of developing competency for process safety engineers.

At Risktec we offer a range of training solutions, from a Masters degree in Risk and Safety Management (delivered in partnership with Liverpool John Moores University), through Risktec Professional Qualifications, to attendance-only courses. Key modules include:

- Hazard identification
- Risk analysis
- Risk reduction and ALARP
- Safety/HSE cases
- Bowtie risk management
- Incident investigation and analysis
- Emergency response and crisis management
- Culture, behaviour and competency

To help demonstrate learning, there are a range of assessment options, from formal case study assignments marked by our practising consultants, to multiple-choice tests.

## Conclusion

Process safety engineering is finally becoming recognised as an engineering discipline in its own right, to stand alongside established disciplines. Industry bodies and professional institutions are making good progress in defining what competencies are expected of professional process safety engineers, but organisations also need to understand what they expect from people in their own process safety roles.

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*With apologies to Douglas Coupland, Canadian novelist.*

# Common Law – The Harmonisation of European Rail Safety

*The Common Safety Method on Risk Evaluation and Assessment* (CSM REA) became a legal requirement in July 2012 throughout European member states. It applies to proposers of all significant changes to mainline railways.

Historically in Europe assurance and acceptance costs have been unnecessarily high where the same or similar rail industry technologies, such as signalling systems, are applied in different member states. The European Commission introduced CSM REA to provide a harmonised framework for the risk assessment process with the intention of addressing a lack of mutual recognition between the member states of corresponding safety methods.

## Radical change or continuous improvement?

During the last couple of years the approach has matured as the industry has come to understand the implications of CSM REA. Experience has shown that it is a refinement and refocusing of approaches in the UK rail industry, rather than a radical shift. Unsurprisingly, there are subtle changes in terminology as Europe adopts a common model; however, the key elements that safety practitioners previously followed remain.

The most novel element, perhaps, is the concept of a 'proposer' – anyone who implements a change to a technical, operational or organisational aspect of the railway system. In the main, this will be the train operators and infrastructure managers, but could also be project entities and manufacturers. Proposers must decide whether the change is considered 'significant' and requires the use of an assessment body to independently review the work. To aid decision making, the proposer produces and assesses a preliminary system definition.

## The risk management process

Once the decision has been made that the change is significant a risk management process is followed, which is a reframing of previous risk management approaches used across the rail industry in Europe.

This starts with the proposer producing a more detailed system definition, based on a refinement of the preliminary definition. This in turn is used as an input to hazard identification, classification and analysis.

The next element of the process which has been refined under CSM REA is in the setting and verification of safety requirements in circumstances where the risk associated with a hazard is not already considered broadly acceptable. The approach adopted is to apply one or more of three risk acceptance principles to each hazard in a prescribed order of priority. Compliance with codes of practice is considered first, followed by comparison with similar reference systems, and finally explicit risk estimation when it is not practical to apply either of the first two principles.

As a final step before acceptance, the proposer needs to demonstrate that the risk assessment principles have been correctly applied and that the system complies with all specified safety requirements through the production of a hazard record. The assessment body will then produce a Safety Assessment Report, drawing a conclusion on the correct application of the risk management process and the end result of its application.

The UK Office for Rail Regulation (ORR) has produced a guidance document on CSM REA, which is further supported by six more detailed guidance documents produced by the Rail Safety and Standards Board (RSSB), to help with implementation:

- Planning an application of the CSM REA
- System definition
- Hazard identification and classification
- Risk evaluation and acceptance
- Safety requirements and hazard management
- Independent assessment

## Will there be further changes?

Following the initial implementation of the regulation, Europe has recognised that unless assessment bodies become accredited there is a chance that consistency will not be maintained. Amendments to the regulations which come in to effect in May 2015 are designed to address this issue by requiring member states to adopt a similar approach to the accreditation of Notified Bodies.

## Conclusion

The CSM REA is a framework that mandates a common European risk assessment and management process for the rail industry. Risk assessment is a familiar concept in the UK and the principles of the regulation are already being applied in most cases. However, some adjustment of project processes has been necessary, particularly concerning the requirement for determining whether a change is significant and the nature of independent assessment.

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