New Environmental Risk Assessment Guidance for COMAH Facilities: Effective Application of an Integrated Risk Management Approach

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An ever-increasing focus on the need to identify and manage risks to businesses, operations and facilities, no matter the industry sector, highlights the importance of risk management specialists from multiple fields of expertise working in an integrated and seamless manner. Factors affecting business continuity range from natural disasters, to security of the supply chain, to safety of workers, to the reliability and integrity of systems, infrastructure, operations and procedures. However, risk experts in each of these different areas sometimes face challenges working together, which include differences in terminology, difficulties in evaluating how best to integrate the findings of independent risk analyses and dealing with conflicting acceptance criteria. Examples of good practice are emerging, and include a multi-disciplinary approach within Groundwater Protection: Principles and Practice (GP3) on the Refurbishment or Redevelopment of Petrol Filling Stations, published by the Energy Institute and Environment Agency (EI and EA, 2013). The Environmental Risk Assessment (ERA) Guidance Environmental Risk Tolerability for COMAH Establishments released by the Chemical and Downstream Oil Industries Forum (CDOIF) in 2014 represents a further example.

While learning from the development of the EI/EA guidance is shared, the focus is primarily on the CDOIF ERA guidance, which requires risk experts from both the process safety and environmental disciplines to work closely together to demonstrate that the environmental risk from a COMAH facility is tolerable.

A case study for a COMAH facility is described which provides a practical demonstration of an effective, integrated approach to risk management of initiating events, hazards and procedures associated with major accidents to the environment (MATTEs). The CDOIF ERA methodology itself is not discussed in depth, but key steps to the process and framework followed are described, including:

- The formation of a skilled, multi-discipline team
- Development of a well-defined, common language at the start of the process
- Dealing with conflicting risk acceptance criteria
- The use of site surveys and workshop sessions to engage multiple stakeholders, including operators
- The preparation of an integrated output to meet the requirements of (largely unconnected) Regulatory/Competent Authorities.

Keywords: Environmental risk assessment, CDOIF, COMAH, integrated risk management, process safety

Introduction

The importance of effective risk management is not a new concept for businesses, no matter their area of focus. Management systems have long been used as one form of business risk management, with a recent trend towards integrated management systems as an aid to considering and managing business risks holistically. Other forms of risk management which typically integrate specialists from multiple disciplines include due diligence as part of asset divestment or acquisition, or organisation mergers and acquisitions. However, one area where integration of risk specialists has historically been poor is in the management of high hazard operations.

Integrated Risk Management for High-Risk Hazard Facilities

High-risk hazard facilities are wide ranging, with large numbers part of the Oil and Gas sector, Chemical Sector and Pharmaceutical Sector; many of these are registered COMAH sites. There has been a focus on the potential impact that these facilities can have on human health and the surrounding environment for more than 15 years. However, often the risks from hazards are considered independently in terms of safety for humans and property compared with potential for damage to the environment (groundwater, surface water, protected species etc.). While safety risk specialists may be more likely to have a background in engineering, environmental risk specialists are more likely to have a background in natural sciences. A common language describing risk and tolerability of risk is not present, leading to the potential for uncertainty, inconsistent decision making and the possibility that a decision made by one risk specialist regarding one receptor could result in an unacceptable risk to another receptor. One such example of where this could have been the case is the development of guidelines regarding storage of petroleum fuels at service stations (EI and EA, 2013). A joint working group comprising safety and environmental risk experts from industry and regulators was established to develop a framework which would balance the need to offer suitable protection to the environment (groundwater and surface water) from the release of fuels from underground storage systems while not resulting in an increased fire or explosion risk to users of service stations. Bringing together specialists with expertise in both safety and environmental risk management in the Oil Sector ensured that the subsequent guidelines promoted an integrated approach to considering all risks, rather than risks to a single receptor.

Environmental Risk Assessment for COMAH Facilities

The concept of assessing the risk to the environment from major accident hazards (MAHs) at COMAH facilities is not new. The COMAH Regulations (1999) put a duty on operators to take all measures necessary to prevent major accidents and limit their consequences to persons and the environment. In 1999, the Department of the Environment, Transport and Regions published guidance (DETR, 1999) that promoted a risk-based approach to evaluating the potential for a Major Accident to the Environment (MATTE). The guidance described the requirement for facilities to undertake an ERA, alongside the overarching principles to be adopted and the thresholds for different receptor types used to determine whether there is a potential for a MATTE. DETR (1999) and associated guidance (e.g. Environment Agency, 2004, 2010) was used widely by operators to assist them in completing ERA for COMAH facilities. This changed in late 2013 when new guidance was published by CDOIF with the aim of providing a clearer framework for carrying out ERAs, together with updates to good practice based on changes in environmental protection legislation since 1999.

Process of Environmental Risk Assessment Prior to October 2013

While a risk-based approach was promoted by DETR (1999) and adopted by industry, the focus of the DETR guidance was on how to determine the likely severity of a release to the environment for a range of receptor types. The guidance had less emphasis on the importance of incorporating the likelihood of a MATTE into the assessment process, or how to quantitatively consider the duration of harm when trying to determine the likely consequence of a MATTE. This resulted in a more prescriptive approach to ERA being adopted in many cases and inconsistency in ERA submissions to the Competent Authority. The uncertainty associated with how to correlate likelihood or frequency of event with consequence (severity and duration) sometimes led to risk mitigation measures, such as tertiary containment, being recommended based primarily on severity of harm to a receptor i.e. a consequence-based approach.

Lessons Learnt Following the Buncefield Incident

In December 2005, an incident occurred that resulted in the destruction of, or damage to, much of the Buncefield Oil Terminal, to other surrounding properties and pollution of the underling Chalk aquifer. The importance of robustly evaluating the risk of a MATTE became even more evident. Taking on board the findings of the Buncefield Major Incident Investigation Board (MIIB), the Buncefield Standards Task Group (BSTG) was formed to develop supporting industry guidance which translated lessons learnt from the incident. The Health and Safety Executive (HSE) subsequently formed the Process Safety Leadership Group (PSLG) to help progress the implementation of the MIIB and other international Major Incident investigation findings. The result of the PSLG work was a report setting out the safety and environmental standards for fuel storage sites (HSE, 2009). This report confirmed that "There are currently no published environmental risk criteria for Great Britain with the same status as those for safety in *Reducing risks, protecting people*", and to fill this gap provided risk tolerability thresholds to be used to evaluate potential MATTEs. The report did not provide a step-by-step framework describing the process of how to assess potential MATTEs. The document was not applicable for all COMAH facilities and greater clarity in approach was still required both from a regulatory and industry perspective to help improve consistency in decision making regarding environmental protection.

Introduction of CDOIF ERA Guidance

In 2011 a CDOIF working group comprising representatives from industry, trade associations, professional bodies and the Competent Authorities was formed, with the aim of developing a framework for assessing the risk to the environment from COMAH facilities. The output of this work was published by CDOIF in 2013, and has been accepted as best practice by the Competent Authorities in England, Scotland and Wales, and should be used to underpin the future development and refinement of ERAs for COMAH facilities. Differences between DETR (1999) and CDOIF (2013) are summarised in Table 1 for each of the key stages in the ERA process.

Table 1. Comparison of key differences between DETR (1999) and CDOIF (2013) for each stage in the ERA process

Component of the ERA	**DETR (1999)**	**CDOIF (2013)**
Stage 1: Assessment of potential MATTE likelihood	No clear guidance on how the frequency of initiating events should be considered	Clear guidance on the likely source of information for the initiating event frequency
Stage 2: Identification of potential environmental receptors	Defined list of potential receptors provided	Defined list of potential receptors provided
Stage 3: Assessment of potential MATTE severity and extent	Threshold values for each receptor based on potential severity and extent	Significant (sub-MATTE), Severe, Major and Catastrophic thresholds defined based on severity and extent
Stage 4: Assessment of potential MATTE duration	No clear guidance on how duration should be considered	Short-term (not a MATTE), medium-term, long-term and very long-term thresholds defined by on duration/recovery

Stage 5: Calculation of (unmitigated or mitigated) risk	No clear guidance on how risk should be calculated	Guidance on how to develop the risk criteria based on a matrix approach combining likelihood, severity and duration per receptor
Stage 6: Evaluation of the risk tolerability	No clear guidance on tolerability of risk within the ERA context	Risk tolerability matrix provided to enable decision as to whether risk is Broadly Acceptable, Tolerable if As Low as Reasonably Practicable or Intolerable

Table 1 illustrates that CDOIF (2013) helps to provide greater clarity to those undertaking or reviewing ERAs, with a step-by-step approach which culminates in a decision as to whether the (unmitigated) risks are Broadly Acceptable, Tolerable if As Low as Reasonably Practicable (TifALARP) or Intolerable. The assessment of duration of MATTEs within the risk matrix scheme is a key factor in the TifALARP determination exercise. The guidance provides further support regarding next steps should the initial evaluation indicate that the risk falls within the TifALARP or Intolerable categories, including how to determine further risk mitigation requirements and the use of cost-benefit analysis (CBA).

Application of CDOIF ERA Guidance in Practice

There is a growing body of examples of the CDOIF guidance having been implemented since its publication in 2013. One such example is a storage and distribution depot located in the Midlands. The facility is a Lower Tier site, storing a range of petroleum fuels within 9 primary above-ground storage tanks (ASTs). The results of a Containment Assessment, carried out for the facility to help evaluate potential for a MATTE following the recommendations of the BSTG (2007), had recommended that further tertiary containment measures should be installed at the facility. This was to mitigate against the potential for off-site migration of liquids under a set of defined release scenarios. However, the recommendation for the tertiary containment had not been determined using a clear risk-based framework and, in any case, the facility understood that the existing ERA would have to be reviewed in light of CDOIF (2013). While potential MAHs had been documented within the Safety Report with associated event frequencies, an early review of the report led to the conclusion that calculations of initiating event frequencies for the potential MATTEs were not available.

Key stakeholders involved in the development of the ERA were identified at the start of the process, including representatives from the facility HSE and engineering departments. A multi-disciplinary implementation team was compiled, ensuring expert input from both from a safety management aspect (to review the suite of MAHs and enable calculation of initiating event frequencies) and an environmental aspect (expertise in geology, hydrogeology, petroleum liquid transport, ecology, hydrology, etc.).

Assessment Methodology

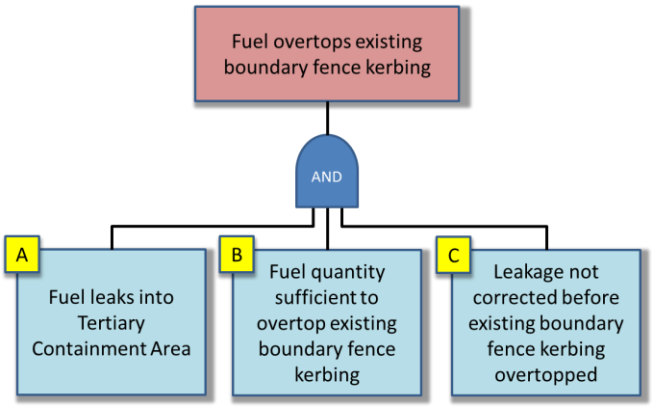
A phased approach to completing the ERA was undertaken, comprising the following:

1. Key stakeholder workshop to agree the MAH(s) with potential for MATTE(s)
2. Calculation of initiating event frequencies for the MATTE(s) by the safety expert
3. Identification of potential environmental receptors by the environmental expert
4. Assessment of the potential severity and duration of the MATTE by the environmental expert
5. Calculation of the (unmitigated/mitigated) risk by the environmental expert with support from the safety expert
6. Evaluation of the risk tolerability by the environmental expert with support from the safety expert
7. Review of the ERA output with the key stakeholders
8. Liaison with the Competent Authority led by the facility.

Phase 1 – Stakeholder Workshop

The value in drawing upon the expertise of multiple stakeholders was identified early in the process. A stakeholder workshop was hosted at the facility, comprising the facility manager, representatives from the facility HSE and engineering departments, an environmental expert and a safety risk management expert. The group undertook a site walkover and then reviewed the MAH in the facility Safety Report, using a simple source-pathway-receptor matrix, to identify whether the scenarios had the potential to represent a MATTE. A top level MATTE threat scenario was agreed (Figure 1).

Figure 1. Conditions for MATTE Scenario



From the existing nine (9) MAH, three (3) were identified as potential MATTEs. A further potential MATTE was identified through the workshop, relating to overtopping of tertiary containment by a fuel-firewater mix. Table 2 summarises the potential MATTEs considered in the ERA.

Table 2. Potential MATTEs considered in the ERA

Potential MATTE	**Description**
01	Overfilling of a storage tank
02	Loss of containment
03	Catastrophic tank failure
04	Tertiary containment overtopped by fuel/fire water mix

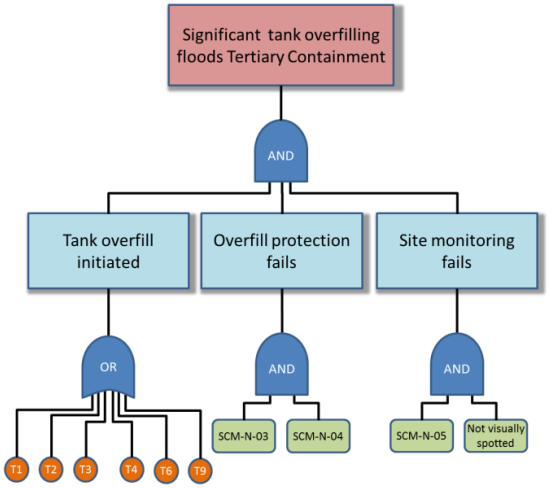
The face to face meeting not only helped to confirm at an early stage where the efforts should be focused within the ERA process, but also provided a forum for each of the risk specialists to:

- Agree a common terminology;
- Discuss the process and mitigate against potential conflicts in risk acceptance criteria; and
- Develop an integrated reporting format to aid document accessibility, no matter the background of the reader.

Phase 2 – Determination of Frequency of Initiating Event

Using the information gathered from the workshop including data within the existing Safety Report, an initiating event frequency was determined using Fault Tree Analysis (FTA) for each of the potential MATTEs. Figure 2 is an example of one of the Fault Trees. Using a combination of literature data and data sourced from the Safety Report, a likelihood was assigned to each causal event and used to calculate an overall likelihood used as the initiating event frequency.

Figure 2. Fault Tree for MAH/MATTE 01.



Phase 3 – Identification of Environmental Receptors

Referring to CDOIF (2013) to identify pertinent receptors to consider, a combination of desk-top information and site-specific information gathered previously through intrusive investigations were used to generate a list of environmental receptors for further assessment. Out of the fifteen (15) potential receptors, this screening exercise confirmed that four (4) receptors required consideration (Table 3).

Table 3. Potential MATTEs considered in the ERA

Receptor Number	Description
06	Widespread habitat (water)
07	Source of public or private drinking water supply
08	Groundwater body
15	Freshwater and estuarine water habitats

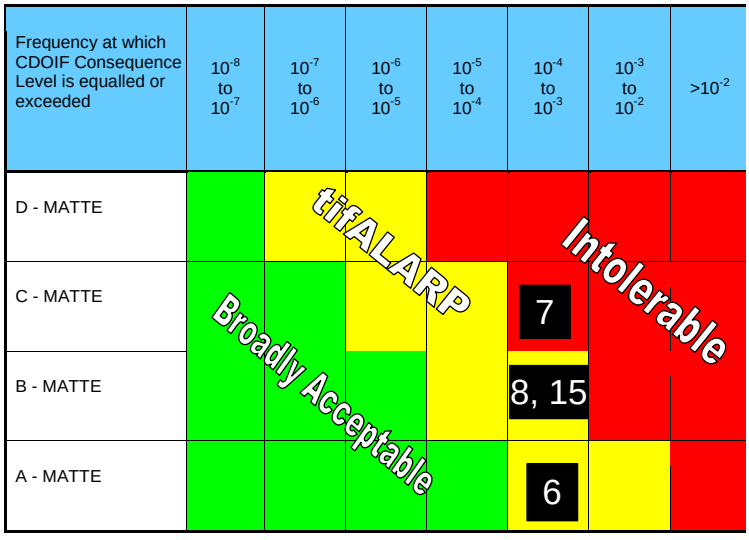
Phase 4 – Assessment of Severity and Duration

While CDOIF (2013) provides guidance on criteria for determining severity and duration of a potential MATTE, expertise is required to evaluate each receptor taking into consideration site-specific conditions. For this example, it was appropriate to undertake a qualitative assessment based on professional judgement. However, the possibility of providing greater certainty in the severity and duration estimates through quantitative analysis (supported by modelling) was kept in mind dependent on the outcome of the ERA. The severity rating for each receptor ranged from Severe (lowest threshold for potential MATTE) to Major, and the duration rating for each receptor ranged from medium term (lowest threshold for potential MATTE) to long term. Plotting severity against duration allowed each receptor to be assigned a single environmental rating from A to D as defined within CDOIF (2013). Receptor 06 was assigned a rating of A, receptor 07 a rating of C, receptor 08 a rating of B and receptor 15 a rating of B.

Phase 5 – Calculation of (Unmitigated) Risk

Using the results of Phase 5, the results of the ERA were plotted upon the risk matrix (Figure 4). The findings indicated that for three (3) of the receptor categories, the risk was tifALARP. For the fourth receptor category (source of public or private drinking water supply) the risk was intolerable.

Figure 4. Results of ERA Assessment



Phase 6 – Evaluation of Risk Tolerability

An important phase in the ERA process is review of the modelling outputs, identifying sensitivities in the assessment and where further quantitative evaluation and/or modelling the effects of different mitigation measures on the output. For this example, review of the findings indicated that receptor 07 was considered at intolerable risk purely as a result of potential for downward permeation of liquid through the unsaturated zone to the underlying aquifer. Subsequent collection of site-specific data on the permeability of the shallow soils (superficial deposits) enabled the risk to receptor 07 (in this case, a Principal Aquifer, used for drinking water supply in the region) to be reduced to tifALARP; the permeability data provided confidence that the superficial deposits would significantly retard the downward migration of liquid to groundwater within the Principal Aquifer. For those receptors with a risk of TifALARP, further detailed modelling was undertaken to evaluate the potential impact of a wall of different heights at defined locations around the facility to provide increased tertiary containment capacity.

Phase 7 – Review of Findings with Key Stakeholders

Prior to submission to the Competent Authority (CA), the results of the ERA were reviewed with the same stakeholder group. This enabled expert practitioner response to any queries and rapid agreement to the findings. Where there was any outstanding uncertainty regarding the process followed, the experts were able to provide coaching to assist with the CA liaison process.

Phase 8 – Liaison with CA

For this example, the final stage in the process was submission of the report to the CA and liaison regarding the outcomes. Combining the results of the ERA with existing tertiary containment plans, agreement was reached that a significant reduction in additional tertiary containment measures was justifiable and suitably protective. While this resulted in a large cost saving for the facility, the key outcome (from the facility's perspective) was regulatory compliance and confidence that the facility could continue to operate with minimal further mitigation requirements.

Conclusions

An integrated approach to risk management is essential in ensuring that decisions made regarding mitigation of risks to one scenario or receptor do not result in an increased and intolerable risk to a different receptor. CDOIF ERA (2013) is one of only a few examples of a framework which brings consistency in approach to assessment of environmental risks in the context of a COMAH safety assessment. For the first time, it is clear for operators of COMAH facilities how the risks to a wide range of receptors can be considered in a comparable manner to existing safety assessments, allowing proportionate but robust decision-making regarding risk mitigation measures. The case study described provides evidence that this new framework can be implemented effectively through a multi-disciplinary team and use of a phased approach to help bring clarity to the ERA process and reduce the potential for undue conservatism or inconsistency.

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