

Practical application of the Chemical and Downstream Oil Industry Forum (CDOIF) Guideline “Environmental Risk Tolerability for COMAH Establishments”

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Introduction

Sellafield Ltd is registered as a Lower Tier establishment under the Control of Major Accident Hazards (COMAH) Regulations 2015.

A key activity, working towards COMAH compliance, is to conduct Major Accident to the Environment (MATTE) assessments.

Sellafield Ltd site is adjacent to a Marine Conservation Zone (MCZ) and near to a coastline Special Area of Conservation (SAC).

Sellafield Ltd worked in partnership with Amec Foster Wheeler utilising the Chemical and Downstream Oil Industry Forum (CDOIF) guideline “Environmental Risk Tolerability for COMAH Establishments 2013 [1], and the “Guidance on the Interpretation of Major Accident to the Environment for the Purpose of the COMAH Regulations”, by the Department of the Environment, Transport and the Region (DETR) [2].

The assessment method employed was tailored to facilitate application of the CDOIF method for assessing the risk of Major Accident to the Environment (MATTE), and incorporates the CDOIF risk ranking method and matrix.

Definition of a Major Accident to the Environment (MATTE)

COMAH 2015 clarifies the definition of a MATTE by the following text: ‘an incident will also be a major accident if it results in serious danger, whether realised or potential, to the natural or built environment. The effect may be immediate or delayed and may sometimes be relatively long-lasting but not necessarily irreversible. Operators should consider the potential for widespread loss or damage to the general environment as well as the risk adverse effects on a rare, unique or otherwise valued component of our natural or built environment. Details of the surroundings will form part of the safety report for upper-tier establishments.

A MATTE scenario is therefore an acute event which has the potential for severe, long-term / permanent damage to the built or natural environment (e.g. ancient monuments or eco systems).

Environmental Risk Assessment Methodology

The adopted model for environmental risk assessment follows a **Source** → **Pathway** → **Receptor** model as is outlined within CDOIF and DETR Guidelines

- Source – Assessment of the properties of the substance, identification of environmental hazards and potential impact on receptors
- Pathway – Review of onsite pathways, assessing how a release could breach site containment and the assessment of offsite pathways to identified vulnerable receptors
- Receptor – Determination of the consequences of release on vulnerable receptors, with analysis of the environmental tolerability by the receptor. This is further assessed considering:
 - Severity of harm on the receptor (the extent of the effect in terms of area % or of habitat affected)
 - The harm duration and / or receptor recovery timeframe

In addition to the severity and harm of the scenario, the likelihood of the scenario occurring is used to find the overall environmental risk of the scenario.

The CDOIF guidelines require the risk level of an *unmitigated* release to be determined and compared to a set of MATTE threshold criteria; these vary depending on the receptor type and vulnerability. Unmitigated releases do not take credit for any safeguarding measures (e.g. operator intervention, containment, isolation)

The CDOIF guidance adopts a screening approach. Where unmitigated release is Sub-MATTE then no further assessment is undertaken. However where the potential for MATTE is identified in the initial scenario screening, further assessment is required to provide a refined understanding of the level of risk posed and the effectiveness of the safeguarding measures in place.

MATTE threshold criteria are outlined below within Table 1.

Table 1: MATTE Definitions and Damage Criteria

Medium	Receptor	Threshold
Land / Water	Natura 2000, Ramsar sites.	Greater than 0.5 ha adversely affected or greater than 5% of the area of the site is affected. Greater than 5% of an associated linear feature adversely affected. Greater than 5% of a particular habitat or population or individual species adversely affected.
Land	Other designated land, ESAs, AONB, Greenbelt land, National Parks, LNRs, Wildlife trust sites, Common land, Country parks.	Greater than 10% or 10 ha of land damaged whichever is lesser.
Land / Water	Scarce habitats, Biodiversity action plan habitats. Geological features.	Damage to 10% of the area of the habitat or 2 ha whichever is lesser.
Land / Water	Widespread habitats. Agricultural land that has not been otherwise classified.	Contamination of 10 ha or more of land which, for one year or more prevent the growing of crops or the grazing of domestic animals or renders the area inaccessible to the public.

If the unmitigated risk is considered to be 'intolerable' or tolerable if as far as reasonably practicable (TifALARP), then risk management strategies would normally be considered within a MATTE assessment. (Hierarchy of control)

- Elimination of the risk
- Prevention of the risk
- Control of the risk
- Mitigation of the risk through emergency responses

Severity of Harm

The criteria for the determination of the level of consequence of an unmitigated release are outlined within the CDOIF guidance. The severity levels of Significant, Severe, Major and Catastrophic are also established within the guidance for each receptor type, with guidance included on the boundaries between these severities of harm categories. The severity of harm levels for each receptor type is duplicated from the CDOIF guidance in Table 1.1.

Table 1.1: MATTE Severity of Harm

Row	DETR Table Ref	Receptor Type	Severity of Harm				Reference to CDOIF pp 4 Table 2	Comments
			Significant (While this level of harm might be significant pollution, it is not considered a MATTE)	Severe (DETR Criteria – the lowest level of harm that might be considered MATTE)	Major	Catastrophic		
		Severity Level →	1	2	3	4		
1	1	Designated Land/Water Sites (Nationally important)	<0.5 ha or <10%*	>0.5 ha or 10-50% of site area, associated linear feature or population*	>50% of site area, associated linear feature population	N/A	Land or Surface Water	NNR, SSSI, MNR
2	2	Designated Land/Water Sites (Internationally important)	<0.5 ha or <5% (<5% LF/Pop)*	>0.5 ha or 5-25% of site area or 5-25% of associated linear feature or population*	25-50% of site area, associated linear feature or population*	>50% of site area, associated linear feature or population	Land or Surface Water	SAC, SPA, RAMSAR
3	3	Other Designated Land	<10 ha or <10%*	10-100 ha or 10-50% of land*	>100 ha or >50% of land*	N/A	Land	ESA, AONB, National Park, etc.
4	4	Scarce Habitat	<2 ha or <10%*	2-20 ha or 10-50% of habitat*	>20 ha or >50% of habitat*	N/A	Land or Surface Water	BAP habitats, geological features

Duration of Harm

In addition to the severity of harm for a scenario, the duration of harm (i.e. exposure and the time for recovery) must be reviewed to allow the complete extent of an unmitigated potential for MATTE to be assessed. In the CDOIF methodology for an incident to be considered as a major accident, there must be persistence in the effects caused, or alternately a delay in recovery of the environment to pre-incident conditions. The criteria for duration of harm varies depending on receptor category, as outlined in Table 1.2

Table 1.2: MATTE Duration of Harm


Description	Short Term (Harm with such short recovery is not considered a MATTE)	Medium Term	Long Term	Very Long Term
Harm Duration Category →	1	2	3	4
Land	≤ 3 years	> 3 years or > 2 growing seasons for agricultural land	> 20 years	> 50 years
Surface Water (All except public or private drink water source)	≤ 1 year	> 1 year	> 10 years	> 20 years
Ground Water or Surface Water of Public / Private Drink Water	N/A	Harm affecting non-public drinking water source.	Harm affecting public drinking water source or SPZ.	N/A
Built Environment	Can be repaired in < 3 years, such that its designation can be reinstated.	Can be repaired in > 3 years, such that its designation can be reinstated.	Feature destroyed, cannot be rebuilt, all features except world heritage site.	Feature destroyed, cannot be rebuilt, world heritage site

Receptor MATTE Tolerability

Upon determination of both the severity of harm and duration of harm expected for the scenario, the overall receptor MATTE tolerability can be determined by application of the CDOIF tolerability matrix, as shown in Table 1.3.

Table 1.3: MATTE Receptor Tolerability

Severity of Harm	4	Sub-MATTE Duration	C	D	D
	3		B	C	D
	2		A	B	C
	1		Sub-MATTE Harm		
			Harm Duration Category		
		1	2	3	4



Frequency at which the CDOIF consequence level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

A CDOIF risk matrix can be used, from the values in the table which allows easy visualisation of the frequencies and tolerability regions with regards to varying degrees of MATTE scenarios, as contained in the CDOIF Tolerability matrix Table 1.4. This represents aggregated risk by receptor (i.e. it combines risk from all contributors in its evaluation of tolerability).

Table 1.4: CDOIF Tolerability Matrix

Frequency at which CDOIF consequence level is equalled or exceeded	Frequency per establishment per receptor per year						
	< 10 ⁻⁷	10 ⁻⁷ - 10 ⁻⁶	10 ⁻⁶ - 10 ⁻⁵	10 ⁻⁵ - 10 ⁻⁴	10 ⁻⁴ - 10 ⁻³	10 ⁻³ - 10 ⁻²	> 10 ⁻²
D - MATTE	Green	Yellow	Yellow	Red	Red	Red	Red
C - MATTE	Green	Green	Yellow	Yellow	Red	Intolerable	Red
B - MATTE	Green	Broadly Acceptable	Green	TifALARP	Yellow	Red	Red
A - MATTE	Green	Green	Green	Green	Yellow	Yellow	Red
Sub - MATTE	Tolerability not considered by CDOIF						

Within the CDOIF risk matrix the coloured segments indicate different tolerability rankings:

- Green – Broadly acceptable risk:
- Orange – Tolerable if ALARP (TifALARP)
- Red – Intolerable Risk

If a scenario produces an outcome within the TifALARP (orange) or Intolerable (red) categories then a risk management strategy should be assessed for elimination/ mitigation. Additionally a scenario outcome of Broadly Acceptable (green) does not by itself infer ALARP has been demonstrated. The tolerability matrix is used to benchmark both mitigated and unmitigated risk.

Phase 1 of the Project

Initial data review and identification of priority facilities

The Establishment major Chemical Hazard Inventory (EMCHI) provided

- Substances
- Location
- Quantity
- Concentrations
- Storage Conditions (Solid/Liquid/gas, Temperature, Pressure etc.)

The highest risk catchment areas were established and if substances on site could affect them.

Phase 1a - MATTE Potential

Assessment of substances held on site and their locations which identify the highest quantity of substances, the most hazardous substances, the highest risk catchment areas and the highest risk local environmental receptors and if substances on site could affect them.

- Review of potential MATTE (with completion of CDOIF tables)
 - MATTE substances Table 1 (CDOIF App 5)
 - Receptors in the local environment under the CDOIF definitions for MATTE if affected by events greater than their thresholds (Table 2 CDOIF App 5)
 - Definition of scenarios / substances which could affect receptors at / above the levels for potential MATTE including all credible and high consequence events (Table 3 CDOIF App 5)
 - Substance hazard information for confirmed MATTE risk substances (Table 4 CDOIF App 5)
- The CDOIF guidelines require the risk level of an *unmitigated* release to be determined and compared to a set of MATTE threshold criteria; these vary depending on the receptor type and vulnerability. Leading to the determination of target frequencies

Phase 1b - Risk Screen

- If the unmitigated risk is considered to be 'intolerable' or tolerable if as far as reasonably practicable (TifALARP), then risk management strategies would normally be considered within a MATTE assessment. (Hierarchy of control)

It is important that the initial screening process is completed with the relevant expertise to ensure confidence in a detailed assessment programme. This avoids organisations trying to carry out detailed assessments on relatively minor scenarios creating unnecessary and expensive work.

Phase 1 Outcome

- Assessment of substances held on site and their locations
- Identified highest risk facilities

- Highest quantity of substances
- Most hazardous substances
- Identified highest risk 'catchment areas'
- Identified highest risk environmental receptors
- Initiated the creation of a prioritised programme for detailed Environmental Risk Assessment (Phase 2)

Phase 2 of the Project Overview

- Detailed review of highest risk identified facilities
- Development of conceptual model and Source-Pathway-Receptor (SPR)
 - Review of substances within facility
 - Unit size; storage location; delivery method; protection measures in place etc.
 - Environmental Hazard Identification (ENVID)
 - Identify potential MATTE scenarios
 - Assessment and review of unmitigated 'worst case' scenarios
 - Assessment and review of 'mitigated' scenarios
 - Risk evaluation and ALARP assessment

Pre-Study and Information Gathering / Desktop Review

Extensive research and information gathering was carried out prior to the onsite study to allow the assessments to be conducted effectively.

Key information gathered:

- ✓ COMAH dangerous substance inventory
- ✓ Manufacturer's safety data sheets (MSDS)
- ✓ Control of Substances Hazardous to Health (COSHH) assessments
- ✓ Storage locations
- ✓ General arrangement drawings / layouts and elevations
- ✓ Process descriptions and process flow data sheets
- ✓ Deliveries, loading / unloading operations
- ✓ Containment details, bunding, shared bunds
- ✓ Local groundwork (concrete, substrate)
- ✓ Venting and scrubbing arrangements (air bound MATTE substances)
- ✓ Site layout
- ✓ GIS mapping
- ✓ Drainage plans
- ✓ Operating and maintenance procedures
- ✓ Operational experience of past environmental events
- ✓ Onsite and offsite environmental information.
- ✓ Receptor information on environmentally sensitive receptors offsite
- ✓ Designated area: national (SSSI, NNR, MNR) and international and European sites: RAMSAR, SAC, SPA
- ✓ Other designated land (LNR, AONB, ESA, NSA, greenbelt, national parks, wildlife trusts, national trust, common land / country parks
- ✓ Scarce habitat (land/water), biodiversity action plan habitats/geological features/built heritage (outside of built environment definition)
- ✓ Non-designated land (crops, grazing, agricultural and other widespread habitat eg forestry and amenity)
- ✓ Non-designated water (fishing, amenity or aquaculture)
- ✓ Groundwater (drinking (public/private), non- drinking
- ✓ Soil/sediment type/nature(to 1m depth), including summary baseline of contaminated land
- ✓ Built environment – Grade 1/Category A buildings, monuments, conservation areas
- ✓ Particular Species: high value special protection species (land/air/water) and significant populations (>1% population or >5% of a plant's ground cover in area)
- ✓ Marine: sea bird and mammal density/populations, benthic community, littoral/sublittoral zone
- ✓ Freshwater and estuarine habitats (ponds, estuaries, reservoirs, lakes, rivers and sources for public/private drinking water (including water utilities facilities)
- ✓ Operating conditions for COMAH substances
- ✓ PID/PFD, Cause and effect drawings (relevant to Environment/MATTE hazards)
- ✓ SIL certificates/ Functional Safety Management system documentation for critical equipment
- ✓ Details of remediation and restoration arrangements and plans
- ✓ Emergency onsite / offsite plan
- ✓ Site Environmental summary data (e.g. met data, sea conditions and topographical data)
- ✓ Existing Environmental studies (baseline studies, ecological studies, registers and reports on built and natural environment
- ✓ Existing environmental consequence models including marine dispersion if available
- ✓ Gap analysis/Register of compliance with good practice and applicable codes and standards
- ✓ Safety reports / HAZANs for facility that relate to losses of containment with impact on the environment

Phase 2 Detailed Assessments

The quality of the Hazard Identification (HAZID) is dependent upon the knowledge and experience of team members involved. Therefore, selection of team members is critical for successful ENVID study. The total number of attendees should ideally not exceed 12, including scribe and facilitator.

Members of the Phase 1 Team: Facilitator, Technical Scribe, Operations Specialist, Operator Representative, Drainage Specialist, Process Specialist, Maintenance / Mechanical Specialist, Control and Instrumentation Specialist, Emergency Response Advisor, Health, Safety and Environmental Specialists

Individual competency includes practical knowledge of current and planned operations, relevant experience and qualifications.

The Environmental Impact Identification (ENVID) workshops begin with a Plant Walk Down involving ENVID facilitator and scribe and process specialist

Method

- At the start of the study, the Facilitator introduced the methodology to the participants and outline how the study will be approached
- Prior to the study, the Facilitator identified sub-sections (nodes) appropriate for the establishment under consideration. Example “Road Tanker transit to offload point”
- At the start of each node, the node will be defined to identify the equipment, activities and substances under consideration

The team then:

- Used Guidewords (appendix (i) to identify potential hazardous events and:
- Completed the ENVID table (appendix (ii):
 - Consolidating causes in a single scenario where the effects and safeguards are the same
 - Creating a separate row to analyse different outcomes e.g. toxic release, fire, explosion; and
 - Recording existing safeguards by type (inherent safety, prevention, control and mitigation)

(The format of the (ENVID) recording table was developed so that safeguards can be separated by hierarchy, i.e. inherent safety measures, prevention control and mitigation)

Risk Ranking - Environmental:

The Environmental Risk Ranking applies the method developed by CDOIF and described in the CDOIF Guideline “Environmental Risk Tolerability for COMAH Establishments”. The risk ranking uses three criteria:

- Severity of Harm (the extent of the effect in terms of area of habitat affected) – this factor also depends on the type of receptor that is impacted; **A benchmark LC10 toxicity was established by taking the lowest literature ecotoxicity LC50/EC50 and dividing by 5. This provided an additional layer of conservation to ensure minimal receptor / species damage.**
- Harm Duration / Recovery Criteria: and
- Likelihood (Frequency)
- Where required, recommendations for further detailed analysis, where the output of the high level screening indicates that the residual that the residual risk on one or more MATTE is TifALARP (Tolerable if As Low as Reasonably Practicable) or intolerable (based on the CDOIF classifications)
- Risk evaluation and tolerability assessment
- Control and mitigation measures analysis
- Demonstration that the risk is ALARP (i.e. that All Measures Necessary has been adopted) for environmental hazards. **ALARP review carried out with the team responsible for each MATTE assessment.**

Conclusions

All MATTE Assessments are complete for the identified phase 2 facilities

All identified MATTE scenarios are tolerable if ALARP

Further risk reduction measures identified

References

1. Control of Major Accident Hazards Regulations (COMAH)
2. Covered Major Accidents to the Environment (MATTE)
3. Chemical and Downstream Oil Industries Forum (CDOIF)
4. Guideline Environmental Risk Tolerability for COMAH Establishments published 2014
Does not replace 1999 DETR guidance but provide framework for its implementation

Appendix (i) Guidewords

Hazard Category	Guideword
Environmental Hazards (to land, air and water) (including from firewater run off)	Loss of containment (e.g. substances dangerous to the environment)
	Firewater Run Off (contamination, combustion products, in burned substances)
	Recovery (e.g. clean up chemicals)
	Catastrophic primary containment failure
	Non-catastrophic failure of primary containment (e.g. Tank shell leak)
	Failure of secondary containment including exceeding capacity
	Failure of Tertiary containment
	Tank overflow
	Tank floor failure / surface integrity failure
	Roof Fire / Explosion
	Warehouse Fire
	Incompatible Materials
	Interaction within drainage system
	Fire damage to the environment
	Human Error
	Release to Air / Smoke / Toxic
	Release to Water (marine)
	Release to Water (fresh / estuarine)
	Release to Drinking Water source (treatment / reservoir etc.)
	Release to Groundwater
	Release to Soil / Sediment
	Release to Habitat / Species
	Release to SSSI / Designated site
	Impact on Built environment
Other "Serious Dangers" to the environment involving dangerous substances	Fire Damage
	Thermal Radiation
	Other loss of containment (e.g. asphyxiant)
Human Error / Non-compliance	Maintenance
	Mal-operation (too late/ too early / too much / incomplete / omitted/ right operation on wrong object / Procedural Error or non-compliance

	Checking error (omitted / too late/ too early/ right check on wrong object)
	Ergonomics
	Resource / staff numbers
	Training / Competence
	Stress/ Fatigue
	Complexity of task
	Communication
Loss of primary containment without ignition	Material Selection
	Over Filling
	Over Pressure
	Other process Deviation (Reverse Flow / Misdirected Flow / Level / Temperature
	Thermal Cycling / Fatigue
	Ageing Plant
	Corrosion / Erosion
	Structural Failure
	Impact – Collision / Dropped or Swung Objects
	Cryogenic Failure / Embrittlement
	Maintenance / Cleaning / Containment
Failure of Power / Utilities	Electricity
	Water
	Compressed Air
	Steam
	Natural Gas
	Control Systems
	Communication
External Hazards	Seismic Event
	Flooding
	Lightning
	Aircraft Crash
	Terrorism
	Vandalism / Theft
	Off-site / Neighbouring fire / explosion
	Subsidence
	Historic Site Specific Hazards e.g. Unexploded Ordnance
Other	Previous Incidents

Appendix (ii) ENVID Recording Sheet

TITLE:																		
Date:																		
Title:		1.0: Plant/unit area including any offices, roadways, storage areas, labs, workshops																
Description																		
Scenario Description					Safeguards				Risk - Environmental						What more can be done? (medium/high safety risk and MATTE potential only)	Actions/ Recommendations	Action taken by	Action Number
ID	Hazardous Scenario/ Event	Hazard Category	Cause	Consequences	Inherent Safety	Prevention	Control	Mitigation	Receptor type	Env. Sev.	Harm Duration	Harm Ranking	Freq.	Risk				