Environmental Management of Produced Water

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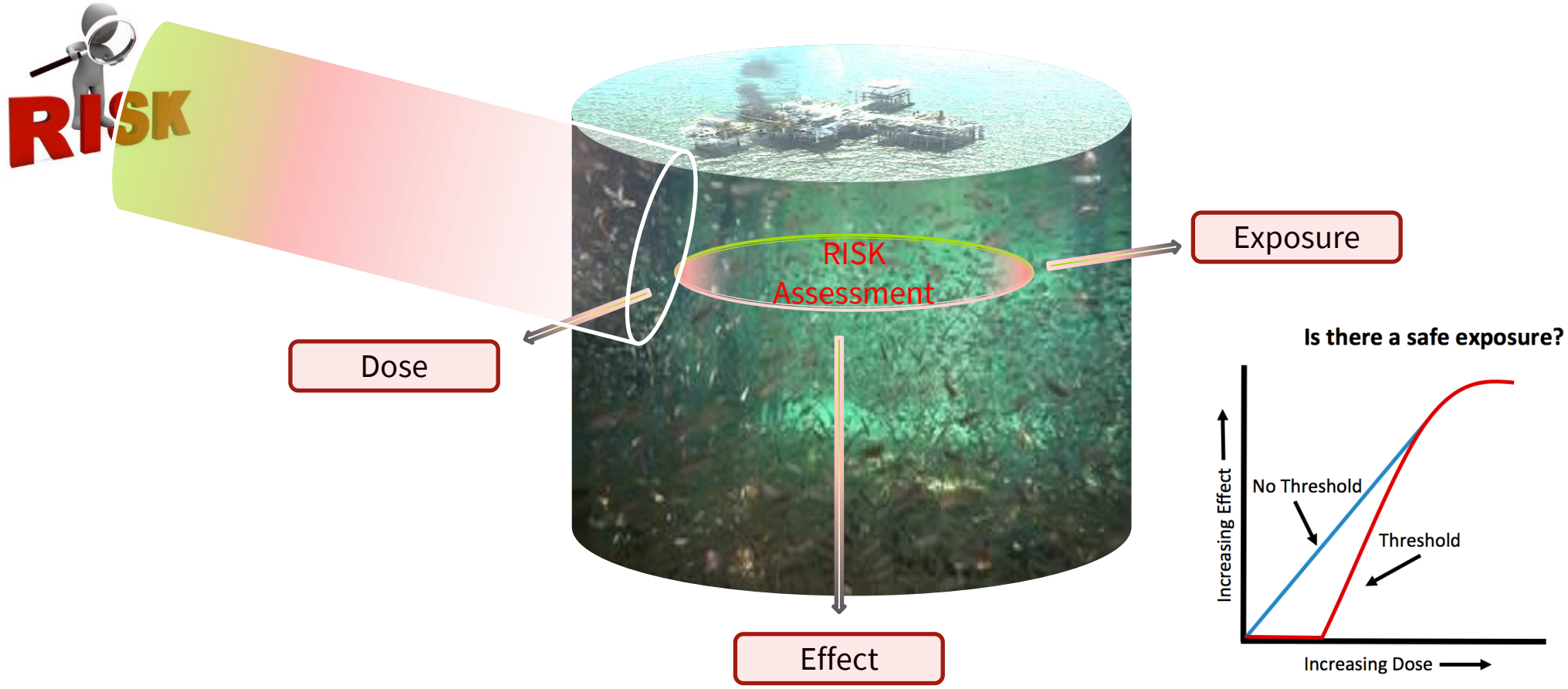
NOV Completion & Production Solutions

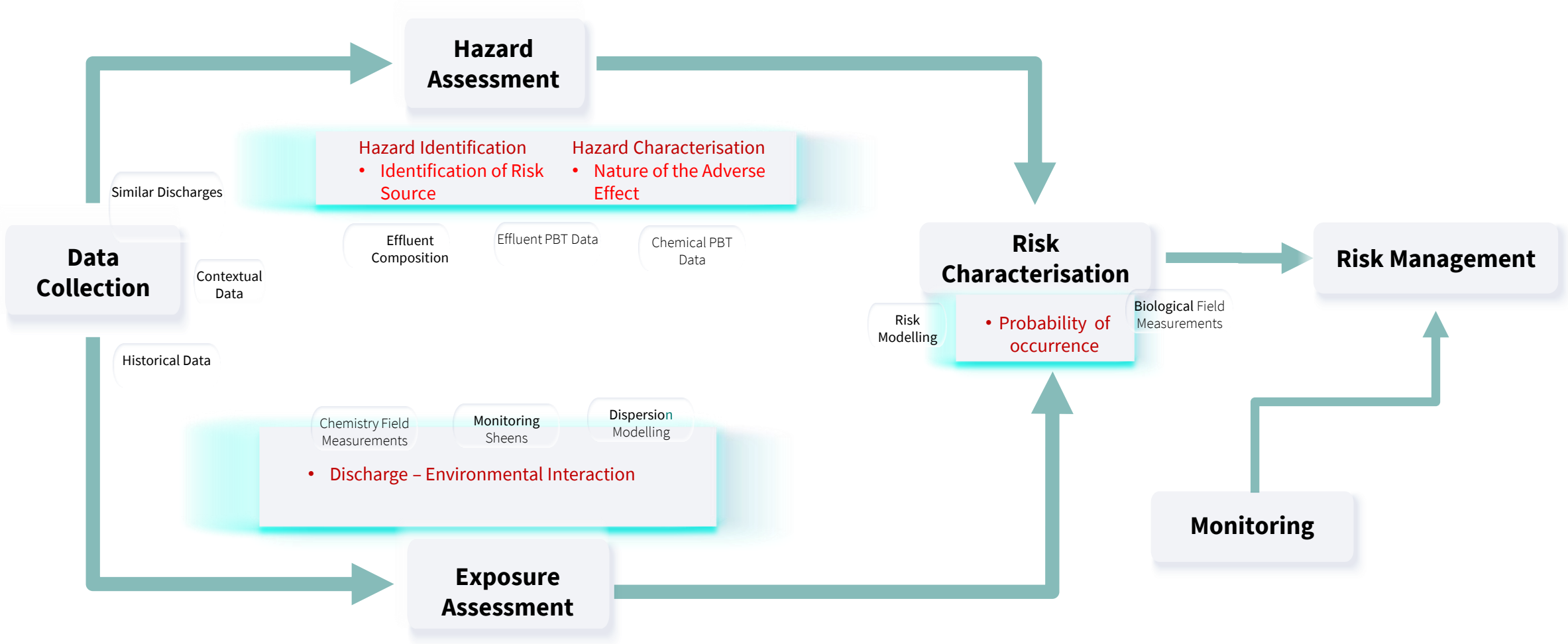
Presentation

- Risk assessment methodology
- UK RBA Implementation Programme
- Global perspective
- RBA outcomes
- Future considerations

Risk Assessment



Risk Based Assessment (RBA)



PEC:PNEC Approach

Criterion			Ref
Definition	PNEC = the concentration below which unacceptable effects on organisms will most likely not occur		EU Technical Guidance Document (EU-TGD)
Assumptions	• ecosystem sensitivity depends on the most sensitive species • protecting ecosystem structure also protects community function		
Limitation	*Pool of data from which to predict ecosystem effects is very limited*		
Availability	Short-term toxicity data	Apply empirically derived Assessment Factors (AFs)	US-EPA and the OECD
Derivation	NOEC (No Observable Effect Concentration)	$L(E)C_{50}$ (50% Lethal or Effect Concentration)	
Arbitration	AF = 10 chronic NOECs are available for three trophic levels (usually algae, crustaceans and fish) + at least two additional marine taxonomic groups	AF = 10,000 Limited set of acute toxicity values	EC 2003 (ECHA 2008)
Goal	**PEC:PNEC**	**Indication of the likelihood of adverse effects**	

The Methodology & Testing Regime

Chemical Analysis:

Biannual testing

Metals

Arsenic
Nickel
Cadmium
Chromium
Copper
Mercury
Lead
Zinc

Alkyl phenols

'C1-C3 Alkyl Phenols' plus 'Othe
C1-C3 Alkyl Phenols'
'C4-C5 Alkyl Phenols' plus 'Othe
C4-C5 Alkyl Phenols'
'C6-C9 Alkyl Phenols' plus 'Othe
C6-C9 Alkyl Phenols'

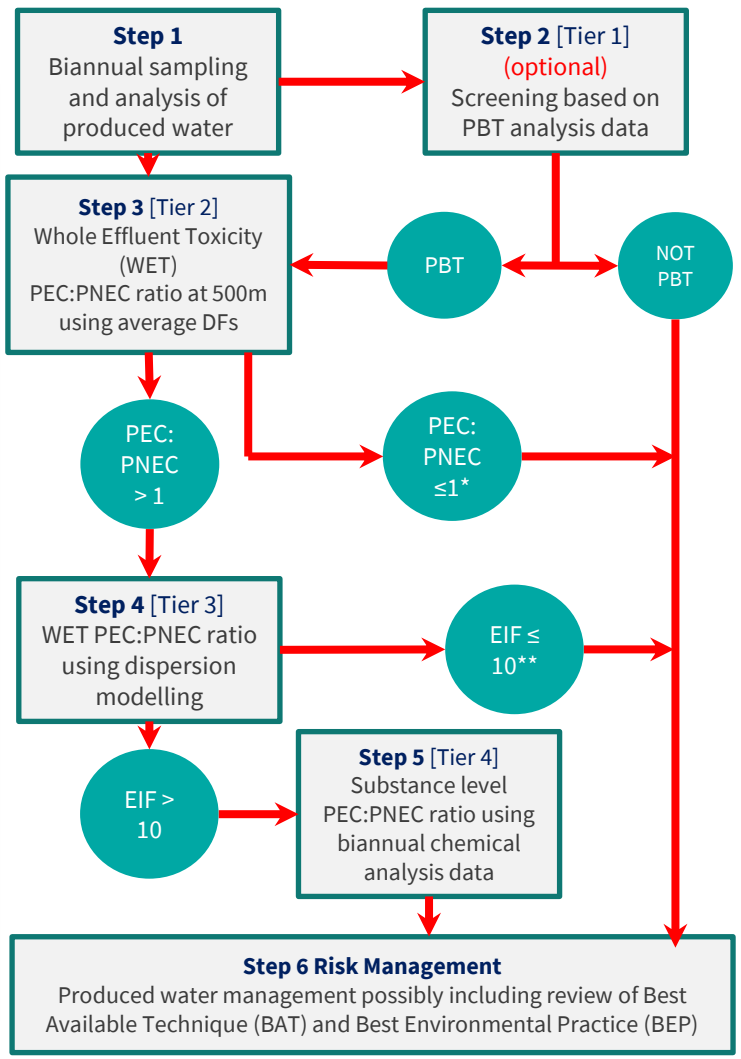
BTEX

Benzene
Toluene
Ethylbenzene
Xylene

Napthalene

Napthalene incl. substitutes.
PAHs
Anthracene
Phenanthrene incl. substituted
Dibenzothiophenes incl. substituted
Fluoranthene
Pyrene
Fluorene
Acenaphtylene
Acenapthene
Chrysene
Benz(a)anthracene
Benzo(b)fluoranthene (5-ring)
Benzo(k)fluoranthene (5-ring)
Benzo(a)pyrene
Benzo(g,h,i)perylene (6-ring)
Indeno(1,2,3-cd)pyrene (6-ring)
Dibenzo(a,h)anthracene

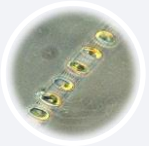
Dispersed oil



WET:

Trophic level testing

Zootoxicity
Acartia tonsa

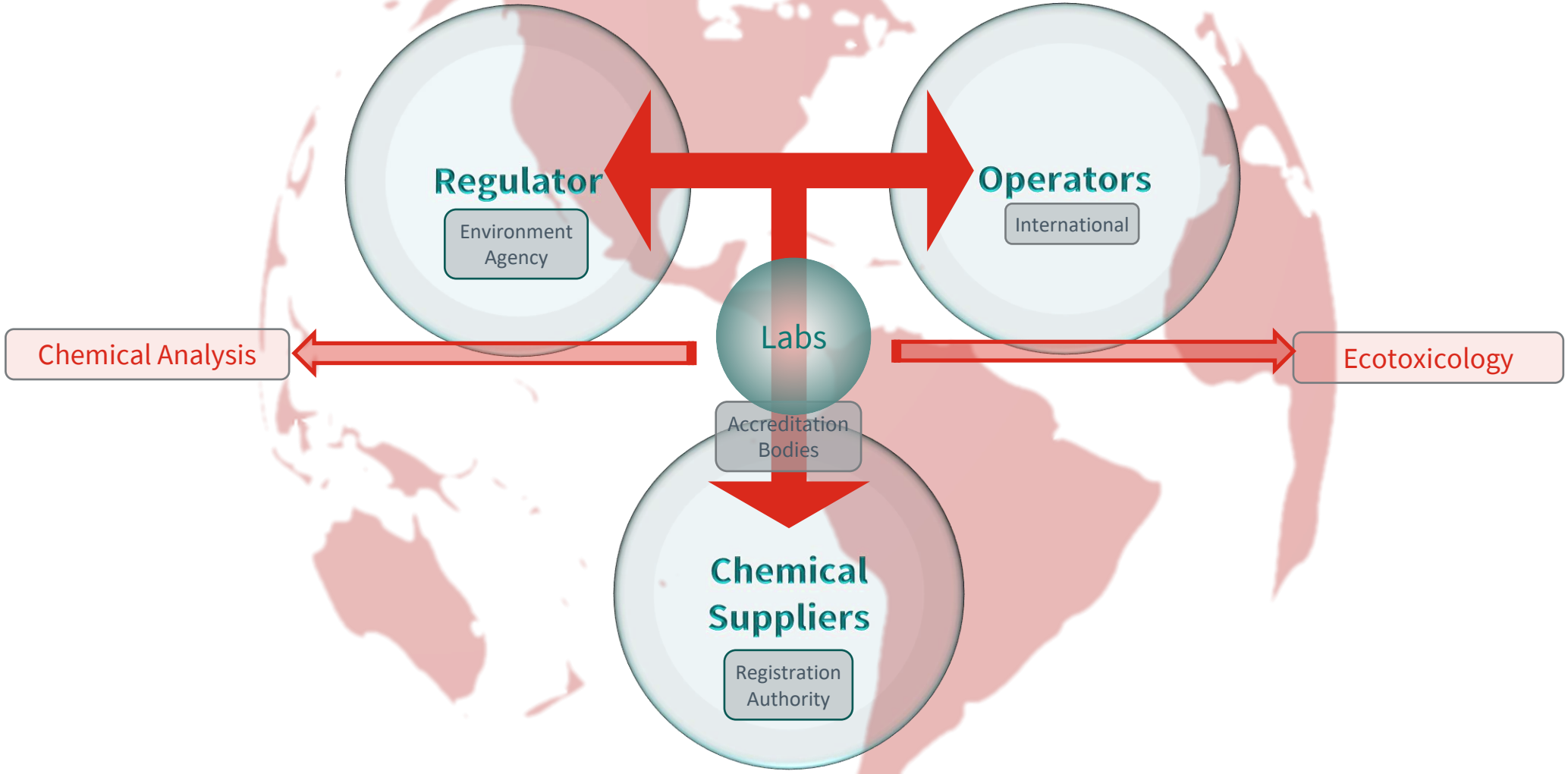


Phytotoxicity
Skeletonema costatum

Microbial
MARA & LumiMARA

Global Regulatory Perspective

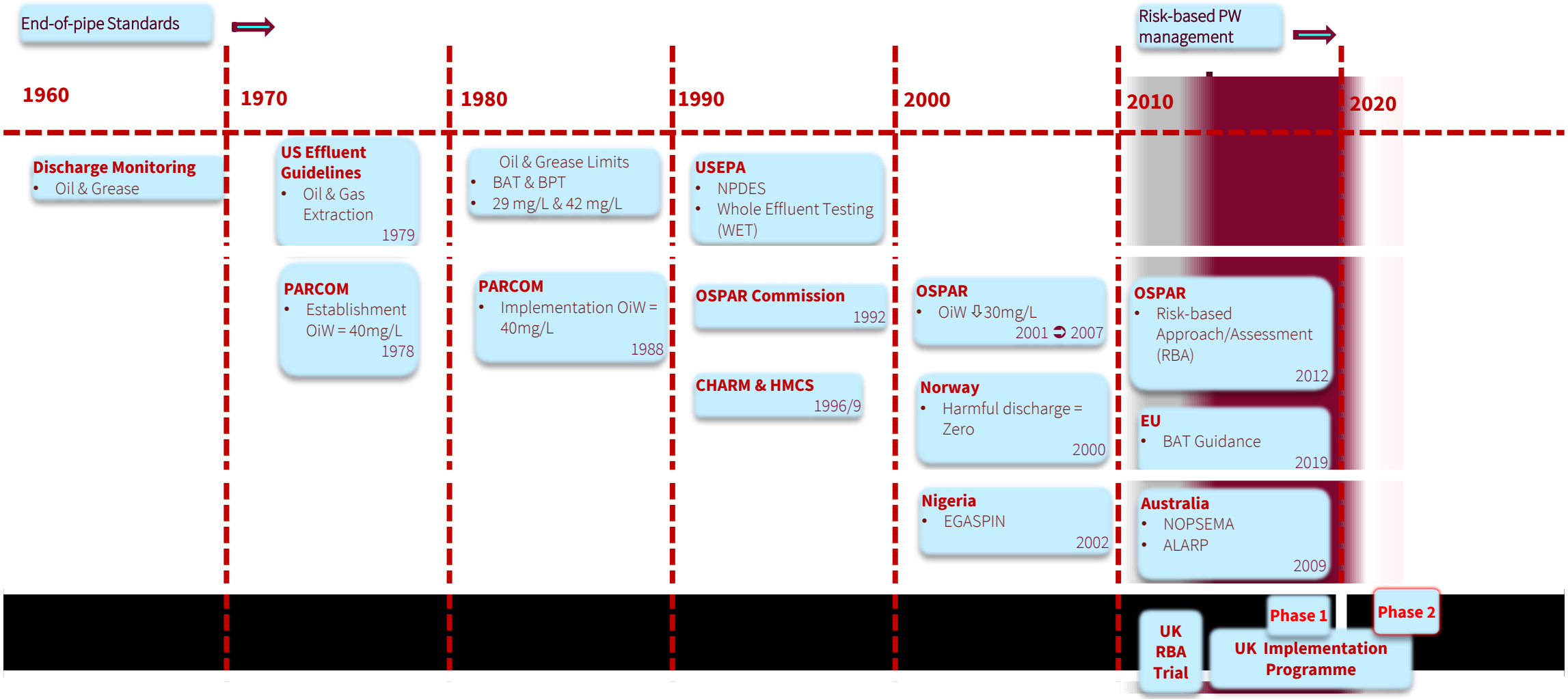
Infrastructure Limitations



Global perspective

The need exists for a unified approach but worldwide the infrastructure lacks the same state of development.

RBA – Chronological Progression



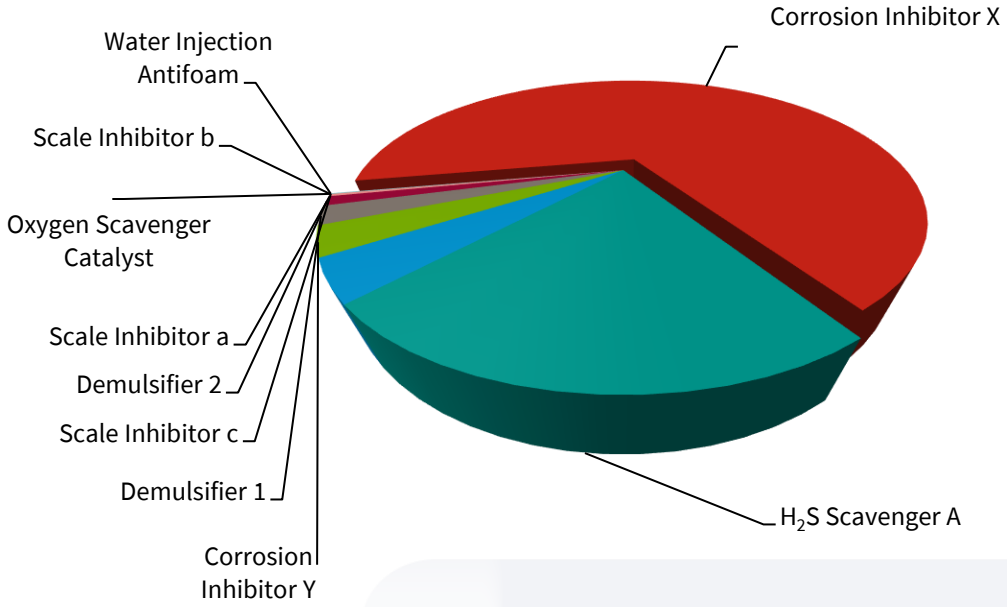
RBA of Offshore PW Discharges

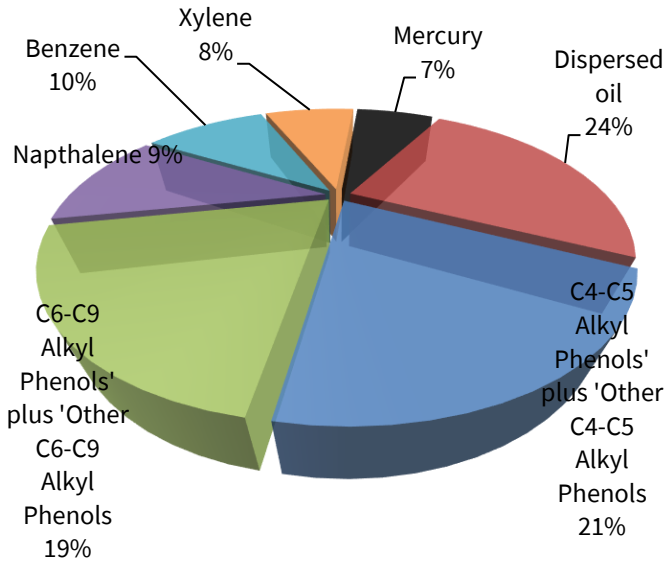
Contents

Risk based Assessment of Offshore Produced Water Discharges Report 633
Sept 2020

Example - Modelling

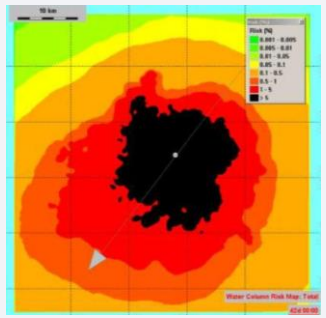
Production chemicals only

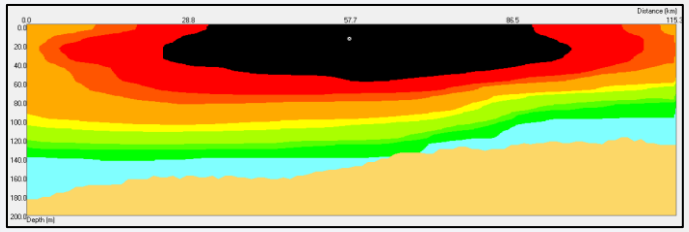


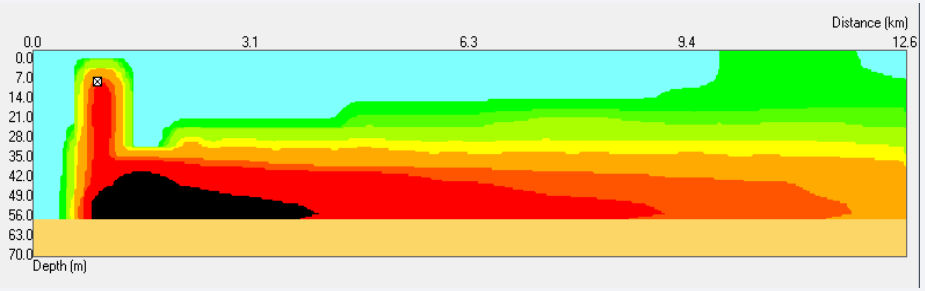


Naturally occurring chemicals only

Maximum risk of whole effluent model

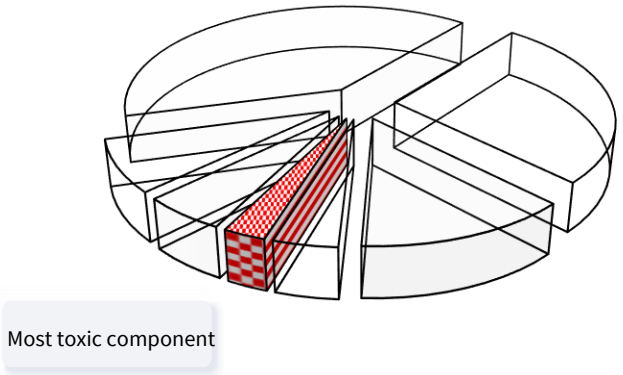


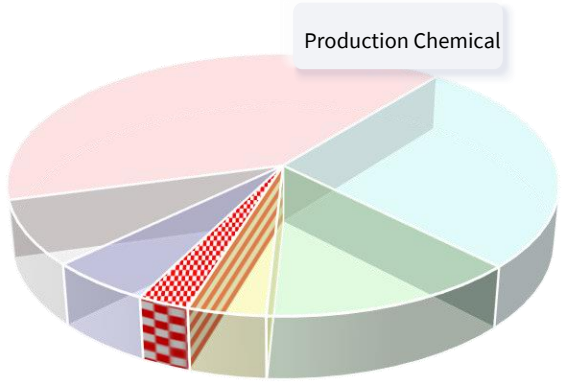


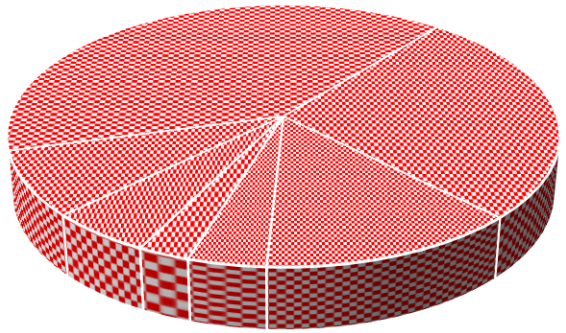


Considerations & Implications

- Added Chemicals data accessibility
  - Each substance data compositional data not accessible to operator



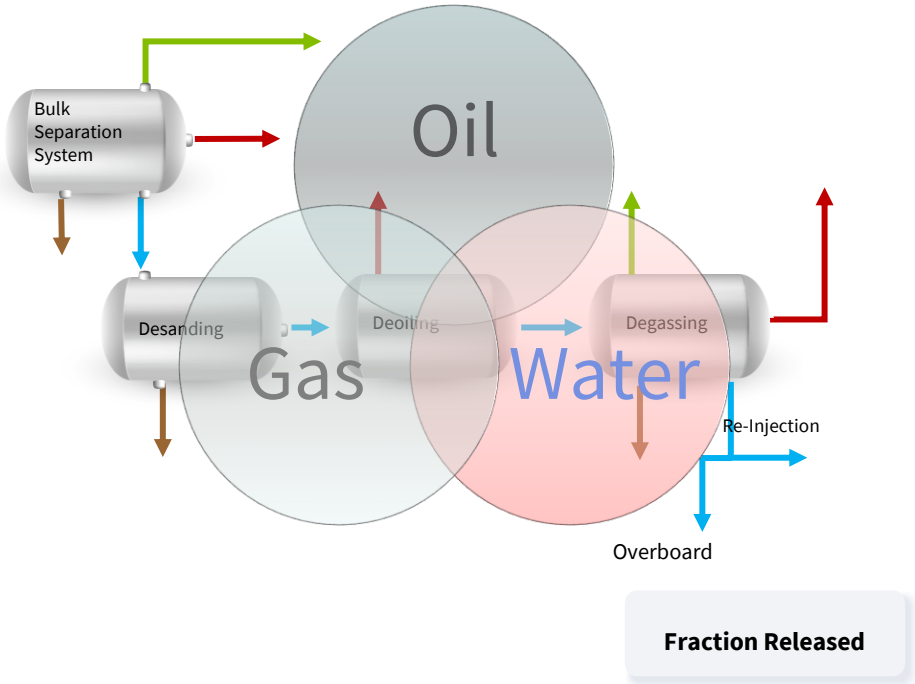




- Tier 4 chemical level assessment leads to significant estimation of EIF
- Naturally occurring substances (NOS) not impacted in same way as added chemicals

Considerations & Implications

- Chemical partitioning



Assessment Factors to derive $PNEC_{aquatic}$

Available Data	Assessment Factor
At least 1 short-term $L(E)C_{50}$ from each of 3 trophic levels (fish, invertebrates (preferred Daphnia) and algae)	1000
1 long-term EC_{10} or NOEC (either fish or Daphnia)	100
2 long-term results (e.g. EC_{10} or NOECs) from species representing 2 trophic levels (fish and/or Daphnia and/or algae)	50
Long-term results (e.g. EC_{10} or NOECs from at least 3 species (normally fish, Daphnia and algae) representing 3 trophic levels	10
Species sensitivity distribution (SSD) methods	5-1 (to be fully justified case-by-case)
Field data or model ecosystem	Reviewed on a case-by-case basis

ECHA R-10

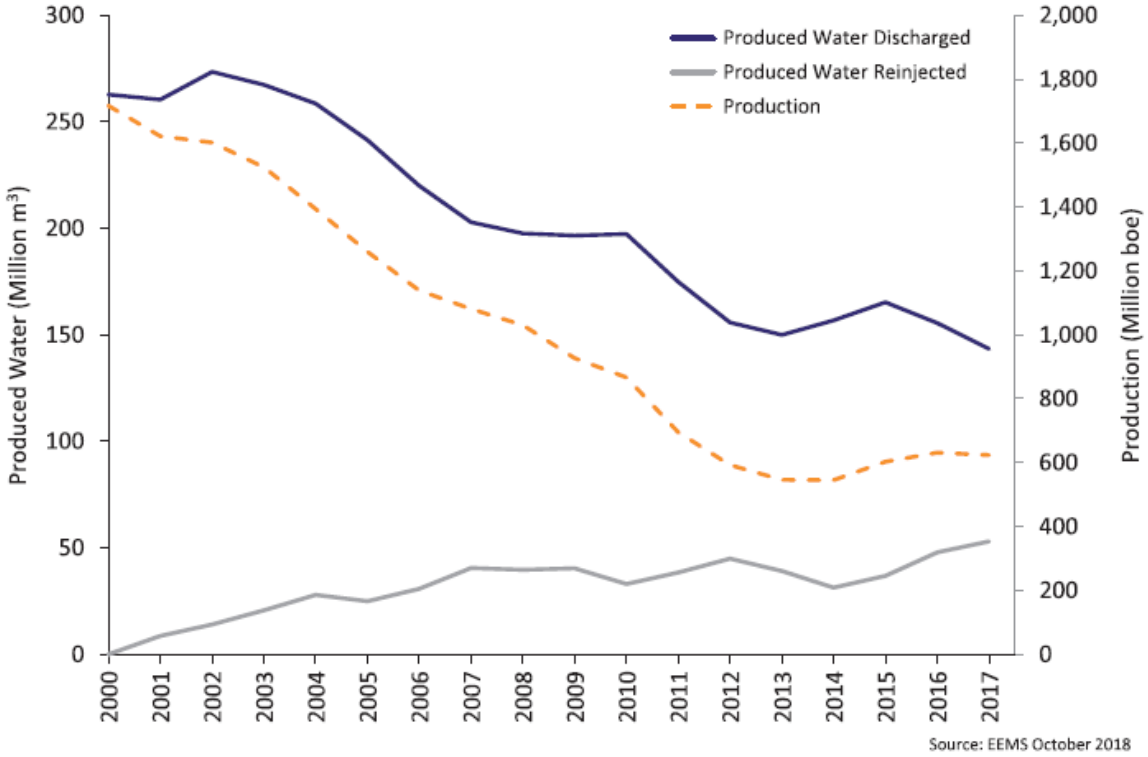
UK – RBA Phase 2

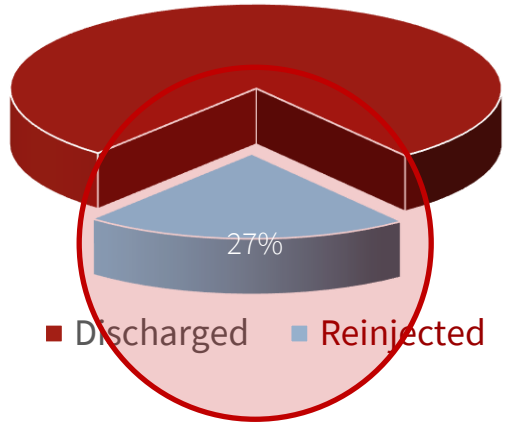
Operator	Full RBA		PW Management Plan (Step 6) by June 2021 - Followed by Full RBA at designated allocation					
	2021		2023		2024		2025	
	H1	H2	H1	H2	H1	H2	H1	H2
BW Offshore / Premier Oil	Catcher							
Bluewater / Hurricane	Aoka Mizu							
Dana Petroleum	Western Isles				Triton			
Neptune	Cygnus							
Total	Culzean				Alwyn North			
					Gryphon Alpha			
Premier Oil	Solan				Balmoral			
BP	Clair Ridge			Clair Phase 1		Andrew	Glen Lyon	
Equinor	Mariner							
Bumi		Kraken						
Perenco		Trent						
Ithaca		Stella	Alba North				Alba FSU	
Apache			Beryl Bravo		Forties Bravo	Beryl Alpha	Forties Charlie	Forties Alpha
			Forties Delta					
Chrysaor			Armada	North Everest	Lomond		Britannia	Judy
Repsol Sinopec			Piper	Auk		Clyde Alpha		Claymore
				Montrose				Bleo Holm
ENI			Douglas OSI					Douglas DP
Enquest	Enquest Producer		Northern Producer {Petrofac}	Thistle Alpha	Kittiwake	Heather Alpha	Magnus	
CNRi			Tiffany	Ninian South	Ninian Central			
CNOOC			Buzzard {Nexen}	Scott {Nexen}				
Taqa			Harding				Brae Alpha	East Brae
							Cormorant Alpha	
							Tern Alpha	
PG Neo				GPIII				
Shell				Nelson	Gannet	Pierce (Haewene Brim)	Shearwater	
						Brent Charlie		
Serica Energy				Bruce {BP}				
Spirit Energy								Sevan Hummingbird
AOC						Anasuria		
Alter Inf						Foinaven {BP}		
Shell / Bluewater								
Alpha Petroleum								Kilmar

UKCS PW Discharge

UKCNS
Around 27% of PW on the UKCNS is reinjected.

Produced Water

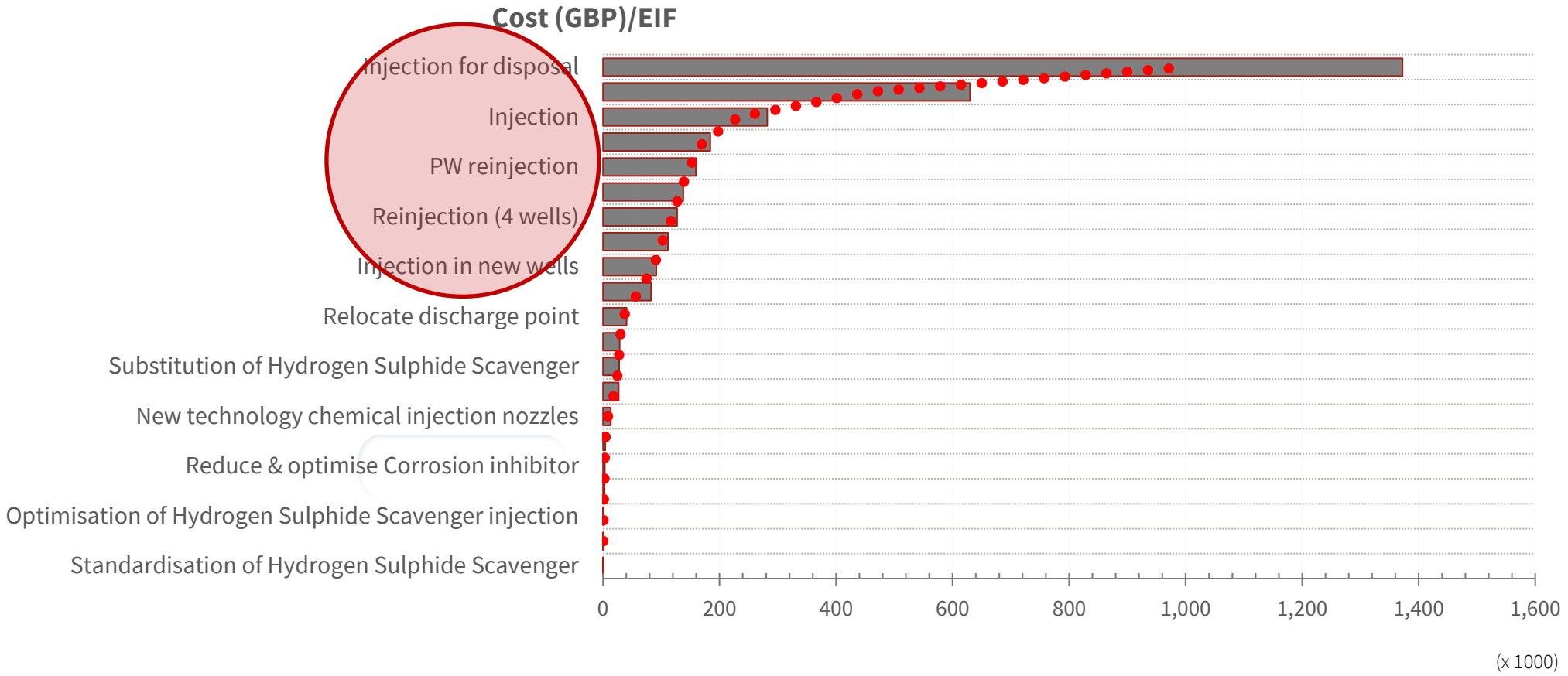




EIF Reduction Strategies

Compliance Process

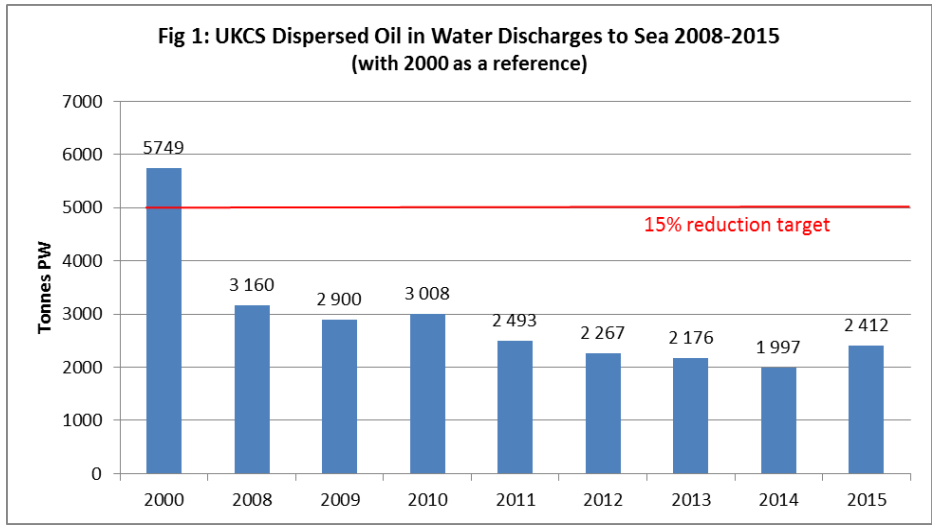
In order to reduce the EIF values instigation of activities entailing change in chemical regime, techniques and technological innovation will be required.
Injection in the final analysis may be required and this could involve significant cost burden

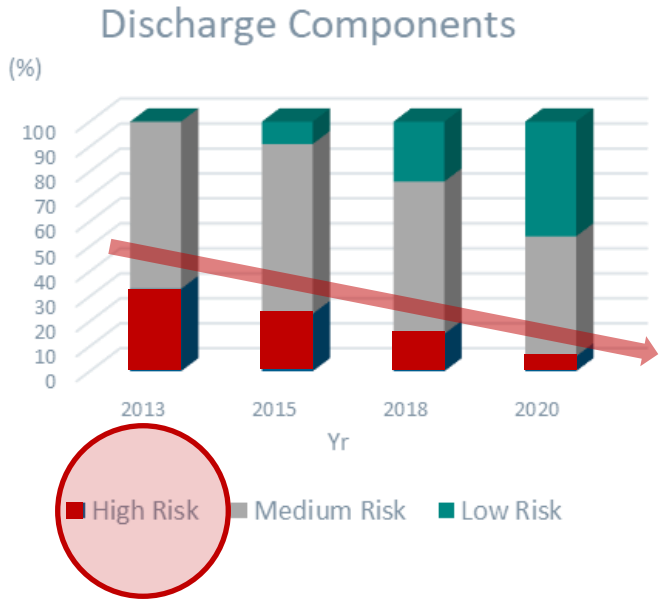


High Risk Components

Aim

The goal is to 'reduce the input of oil and other substances into the sea resulting from produced water from offshore installations, with the ultimate aim of eliminating pollution from those sources'.





GOAL

- *'reduce the input of oil and other substances into the sea resulting from produced water from offshore installations, with the ultimate aim of eliminating pollution from those sources'.*

Ref - UK Implementation Report for OSPAR Recommendation 2001/1 (as amended)
OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic
Meeting of the Offshore Industry Committee (OIC)
Oslo (Norway): 15-17 March 2017

Summary

- Review RBA methodology
- Reduce Assessment Factors (chronic tests)
- Chemical substitution
- Improved produced water management strategies (BAT & BEP)
- Unified global regulatory approach
- Enhanced global infrastructure development