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The SPE Distinguished Lecturer Program is funded principally through a grant from the **SPE Foundation**.

The society gratefully acknowledges the companies that support this program by allowing their professionals to participate as lecturers.

Special thanks to the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) for its contribution to the program.

Understanding and Minimizing the Environmental Impacts of Offshore Drilling Discharges

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Distinguished Lecturer Program
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Today's Discussion

- Drilling discharges continue to undergo regulatory scrutiny, with some countries mandating zero discharge for non-aqueous drilling fluids (NAFs)
  - Is zero discharge worldwide inevitable?
- New seafloor data indicate minimal environmental impact when fluids are properly managed
  - What data are sufficient to satisfy regulators and other stakeholders?
- Management practices that can keep discharge a viable option well into the future:
  - New fluid and cuttings cleaning technologies.
  - Risk based tools to understand and mitigate potential impacts

Drilling Discharge Regulations: Is the World Heading for Zero Discharge?

Country	NAF Cuttings Discharged	Fluid on Cuttings
North Sea	None	1%
Nigeria	None out to 12 miles	5%
Brazil	SBM, >60m depth	6.9% paraffin, 9.6% IO, ester
Angola	OBM/SBM	5%
Gulf of Mexico	SBM, >3 mi	6.9%
Thailand	OBM/SBM	10%

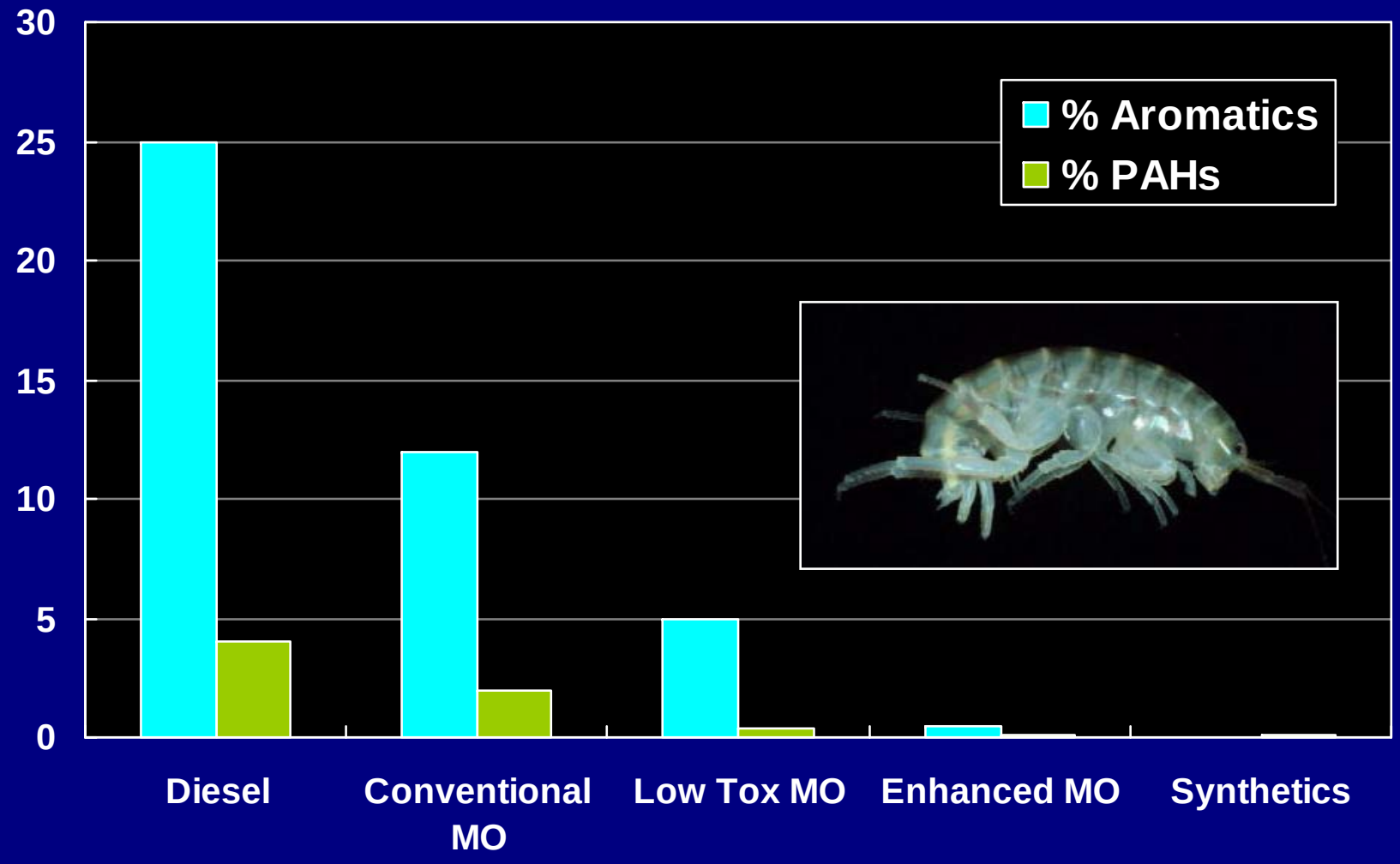
Why Are Countries Mandating Zero Discharge?

- Persistent, large (20m high) cuttings piles: North Sea
- World Bank/IFC Offshore Environmental Guidelines (2007)
- Precautionary Principle – No discharge unless data demonstrates no harm
- Environmental field data unconvincing to stakeholders

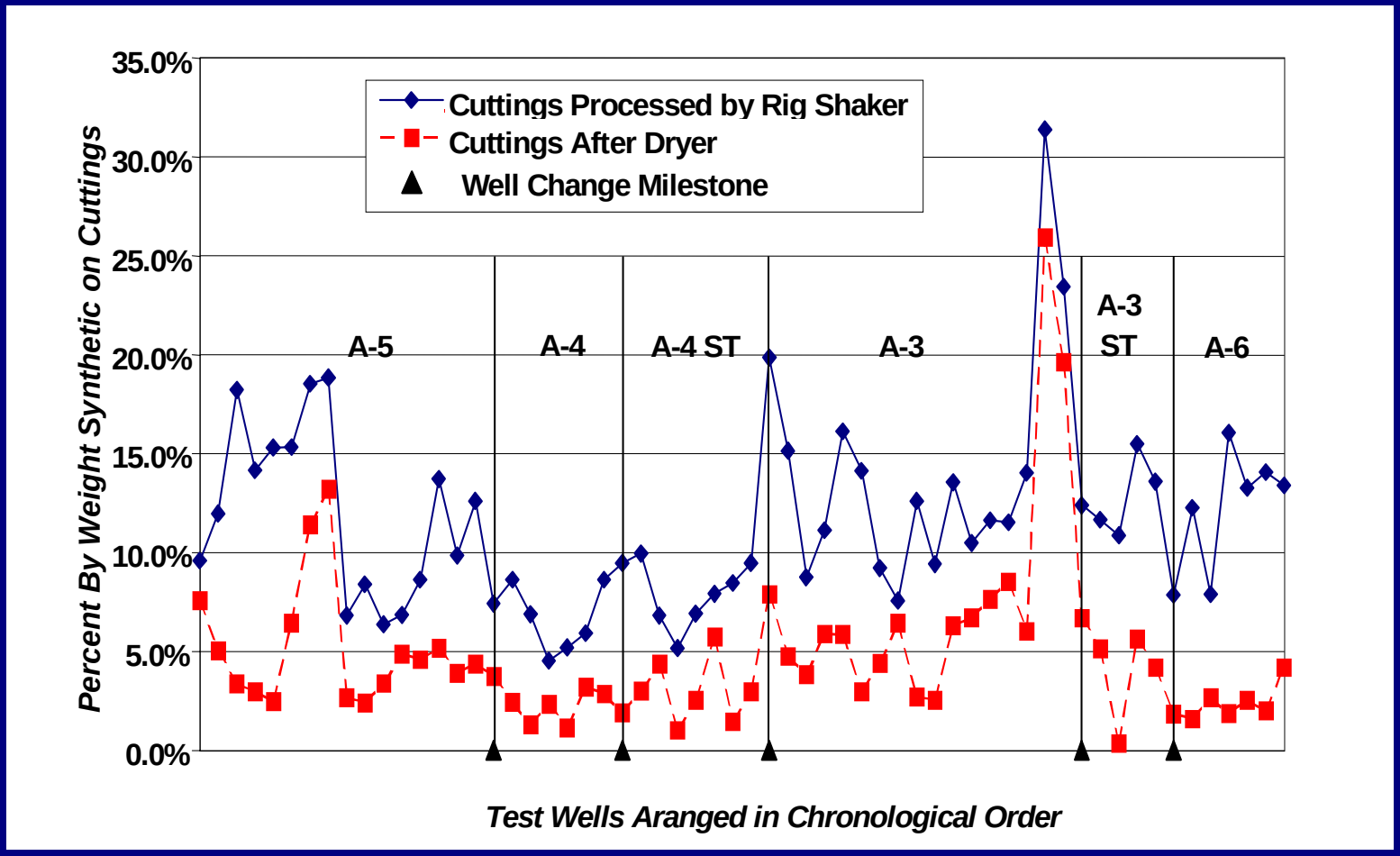
What Has Industry Done to Avoid Mandated Zero Discharge?

- Less toxic, more degradable non-aqueous drilling fluids
- More efficient drill cuttings treatment technologies
- More sophisticated environmental assessment tools and techniques
- Field assessment data from around the world: Angola, Brazil, Azerbaijan, Thailand

Elimination of Aromatics and PAHS: Less Toxic Non-Aqueous Drilling Fluids



New Treatment Technologies Reduce the Amount of Drilling Fluid Discharged



Hammer Mill Technology: Reduces Fluid on Cuttings to <1%

SPE 116169

Friction-Based Thermal Desorption Technology: Kashagan Development Project Meets Environmental Compliance in Drill-Cuttings Treatment and Disposal

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Abstract

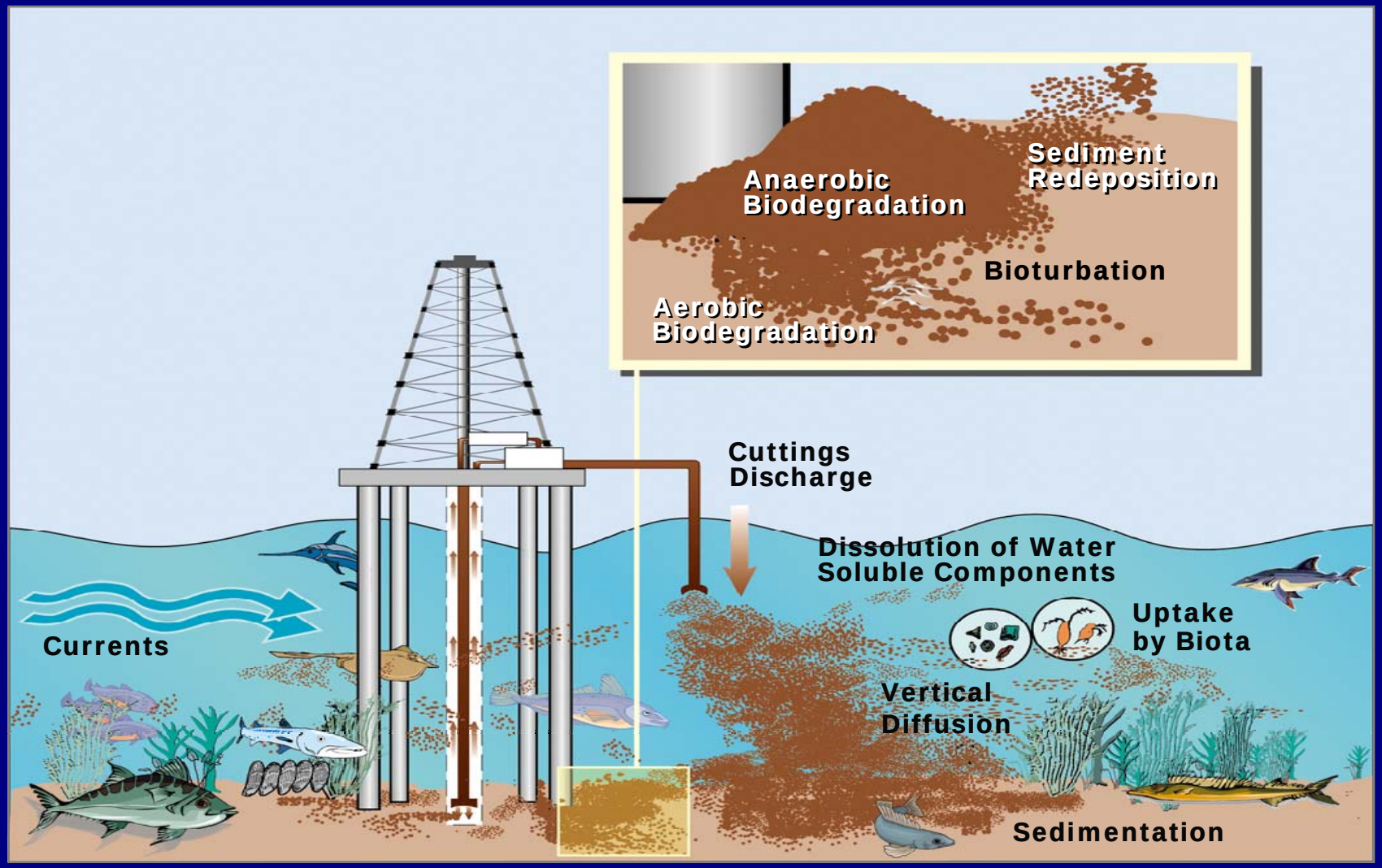
Friction-based thermal desorption, with temperatures between 260 and 300°C, allows the oil and water phases to be volatilized and subsequently condensed and recovered, leaving dried and cleaned solids that can be disposed. Friction-based thermal desorption reduces the residual oil on the cuttings while recovering oil and other materials for reuse.

This paper presents the novel friction-based thermal desorption system currently deployed in the relatively hostile and remote Koshken area, located on the steppe escarpment above the eastern shore of the Caspian Sea, Kazakhstan. This project is expected to produce 50,000 tonnes of oil-based drilling fluid or "mud" (OBM) drill cuttings annually, which must be treated to below 1% TPH oil before disposal. Any treatment technology utilized in this environment faces operational and logistical challenges, including the severe climate and the need to transport the drill cuttings from an offshore facility to an onshore centralized location. Improvements in friction-based thermal desorption technology were developed specifically for the Koshkani project to ensure health, safety and environmental (HSE) compliance and allow a best-in-class system to operate in this harsh environment.

In this paper, the authors describe the three-year development process, from initial design and equipment construction through installation, commissioning and operation. Analytical data presented includes analysis of discharged material, recovered base oil and air emission analysis. A comparison is made between the application of thermal desorption technology and alternative technologies used in similar projects.

Friction-based thermal desorption met increasingly high performance expectations and technology advancements

Industry Has a Better Understanding of Field Impacts

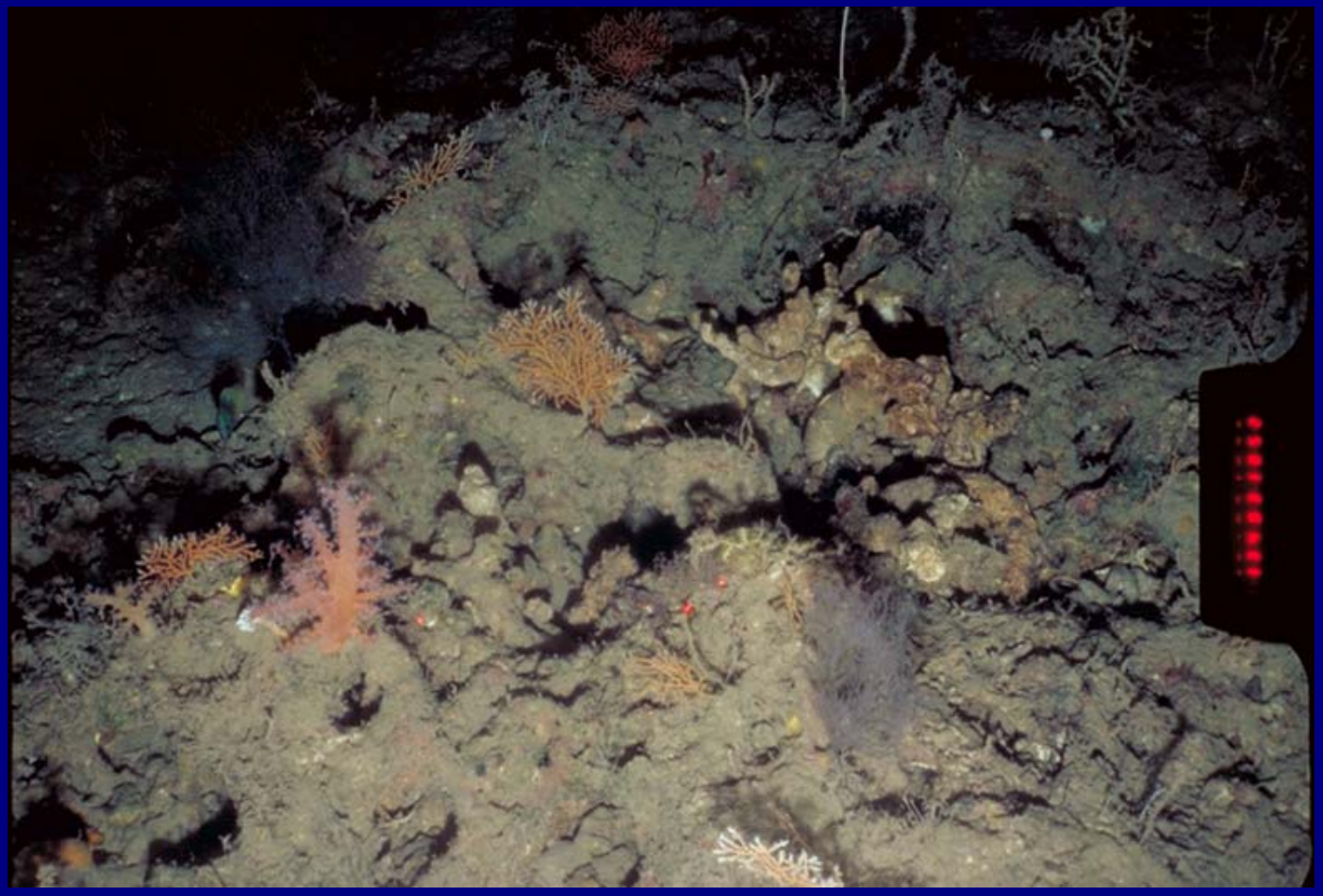


Recent Environmental Survey Data From Offshore Drilling

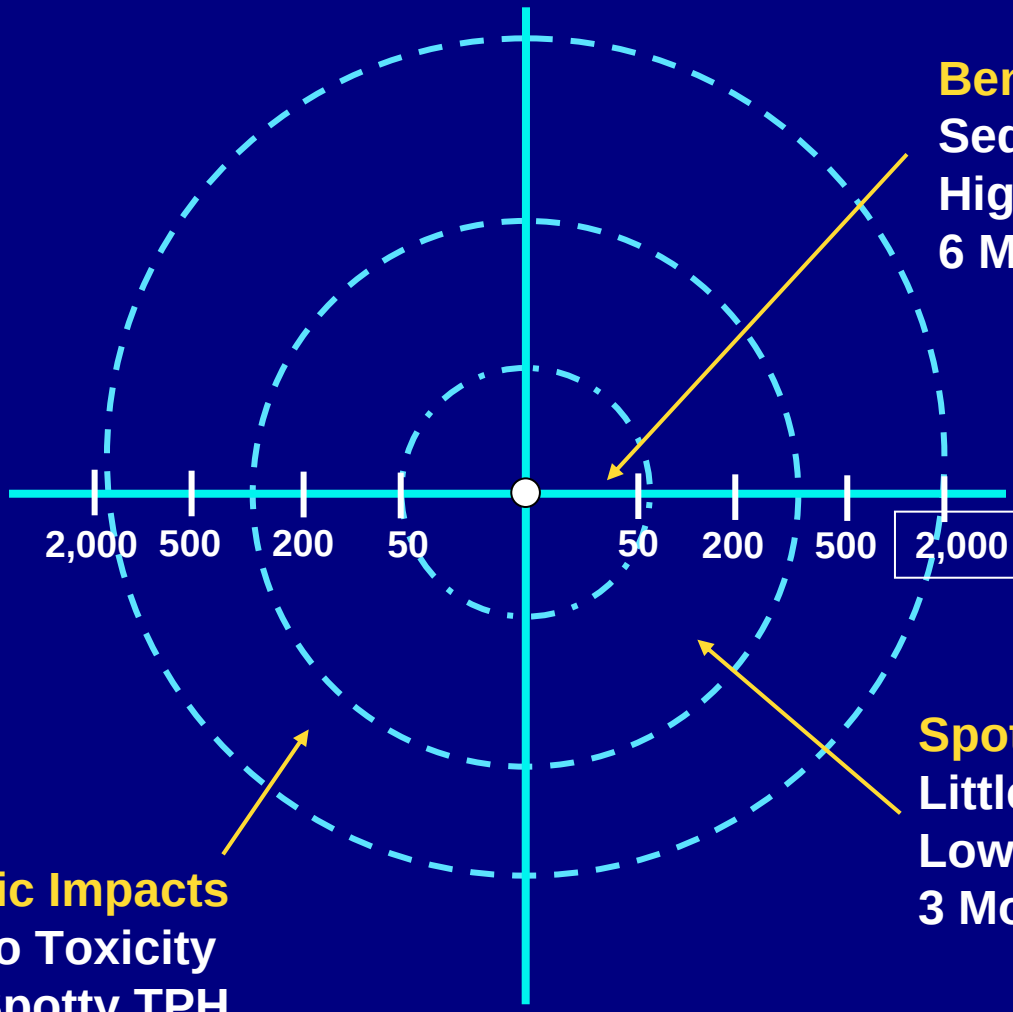
- **USA (SBM Research Group, 2004, MMS, 2005)**
  - **Evaluated several sites that used WBM and SBMs at water depths ranging from 37 to 556m**
  - **Impacts mostly limited to within 100m of discharge**

- **Brazil (MAPEM, 2003)**
  - **Evaluated shallow (200m) and deepwater (902m) sites drilled with synthetic paraffin**
  - **Recovery evident at both sites within two years after drilling**
  - **Impacts more related to physical deposition of cuttings versus chemical toxicity**

Marine Life Around Synthetic Drill Cuttings



Conceptual Model: Environmental Impact of SBM Cuttings

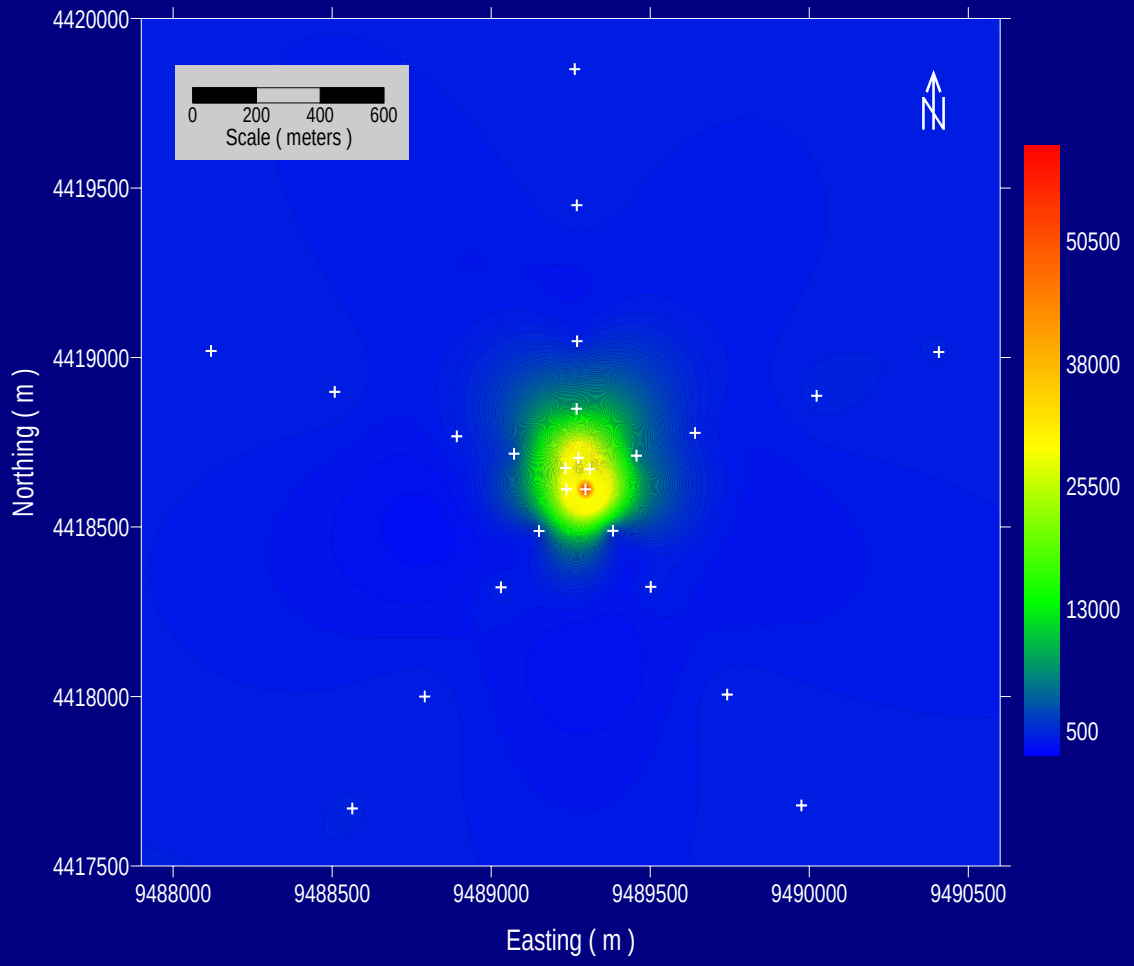


Benthic Impacts
Sediment Toxicity
High TPH
6 Mo. - 3 Yr. Recovery

Spotty Benthic Impacts
Little or No Toxicity
Low TPH
3 Mo. - 2 Yr. Recovery

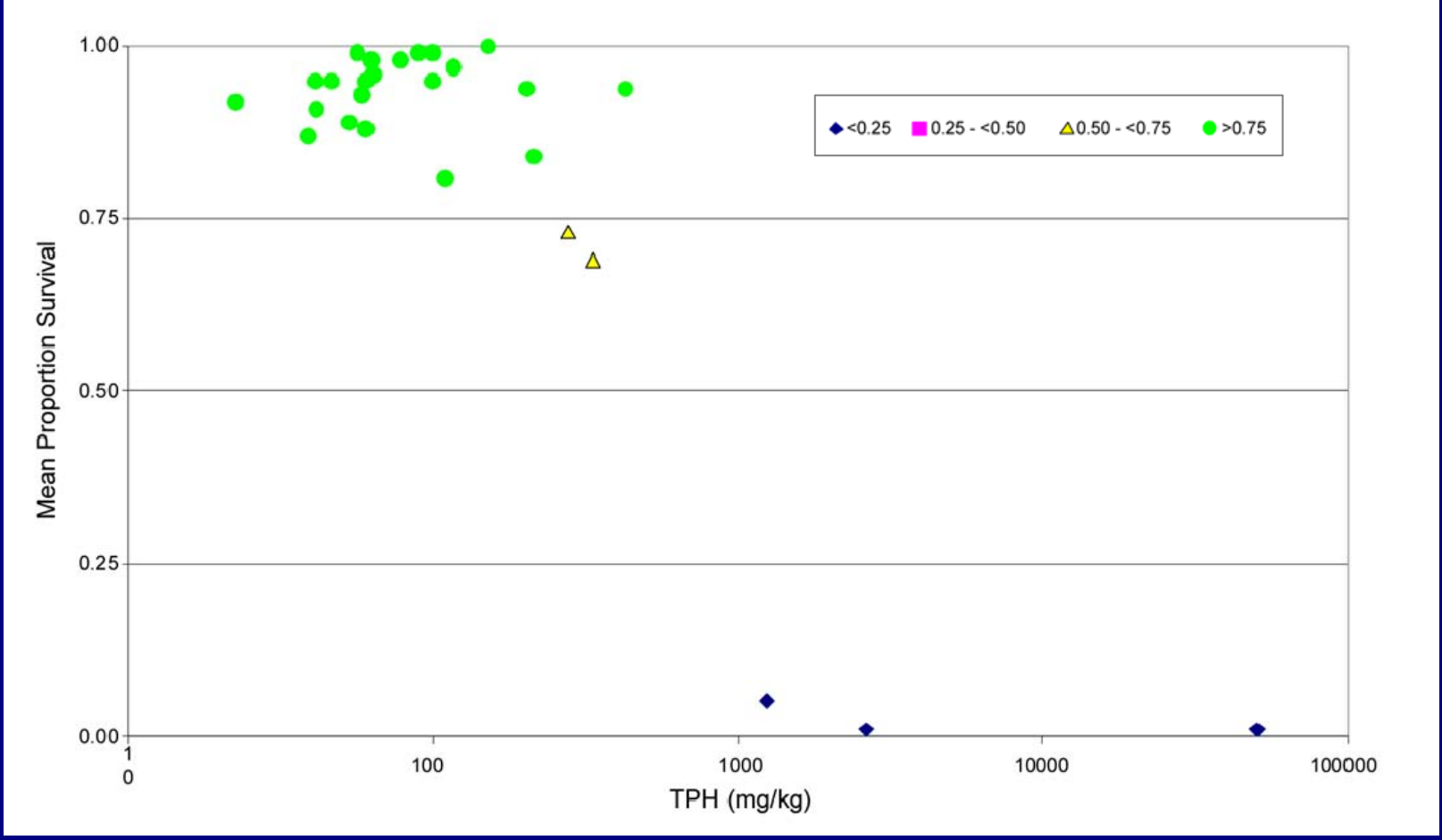
No Benthic Impacts
No Toxicity
Spotty TPH

Distribution of Synthetic Drilling Fluid at Southern Caspian Exploration Well Site



Total LAO (unresolved, µg/g dry weight)

Correlation Between TPH and Amphipod Survival in Sediments in the Vicinity of Drilling Operation



New Screening Tool to Evaluate Potential Risk

- **Simple matrix evaluates potential impacts by considering:**
  - **Current velocity, water depth, seabed temperature**
  - **Type of mud, volume of muds and cuttings to be discharged**

Screening Evaluation Worksheet

Screening Matrix to Assess NAF Drilling Discharge Potential Impacts				
Parameter	Value			
	1	2	3	4
Velocity of currents	Slow →			Fast
Temperature of seabed water	Cold →			Warm
Depth to sea bed	Shallow →			Deep
Biodegradation and toxicity of fluid	Low toxicity, high biodegradability →			Lowest toxicity, highest biodegradability
Volume of non-aqueous fluid discharged in program (bbl)	Large →			Small
Volume of drilled cuttings discharged in program	Large →			Small
			Total Points:	≥X

Screening Evaluation Example

Hypothetical Project X: Somewhere Offshore (18 Wells)				
Parameter	Value			
	1	2	3	4
Velocity of currents	Slow →			Fast
Temperature of seabed water (°C)	Cold →			Warm
Depth to sea bed (ft)	Shallow →			Deep
Biodegradation and toxicity of fluid	Low toxicity, high biodegradability →			Lowest toxicity, highest biodegradability
Volume of non-aqueous fluid discharged in program (bbl)***	Large →			Small
Volume of drilled cuttings discharged in program	Large →			Small
			Total Points:	12

Offshore Drilling Discharges
Screening of Overboard Discharge

- **Screening Evaluation Worksheet (Continued)**
  - **If sum of values is ≥12, then discharge is allowed**
  - **If sum is ≤12, then offshore discharge should be reevaluated – Reevaluation should consider**
    - **Modification to drilling program and equipment**
    - **Modification to drilling fluid selection**
    - **Evaluation of drilled cuttings deposition, e.g., computer modeling or pre- and post-drill environmental monitoring**

Conclusions

- Zero discharge of drilling muds and cuttings remains an issue, However:
  - New technologies reduce or prevent impacts
    - Less toxic, more degradable drilling fluids
    - Better cuttings treatment
    - Risk based assessment tools
  - Recent environmental studies indicate:
    - Impacts extend a relatively short distance from the drilling site
    - Impacts less persistent compared to impacts from past practices