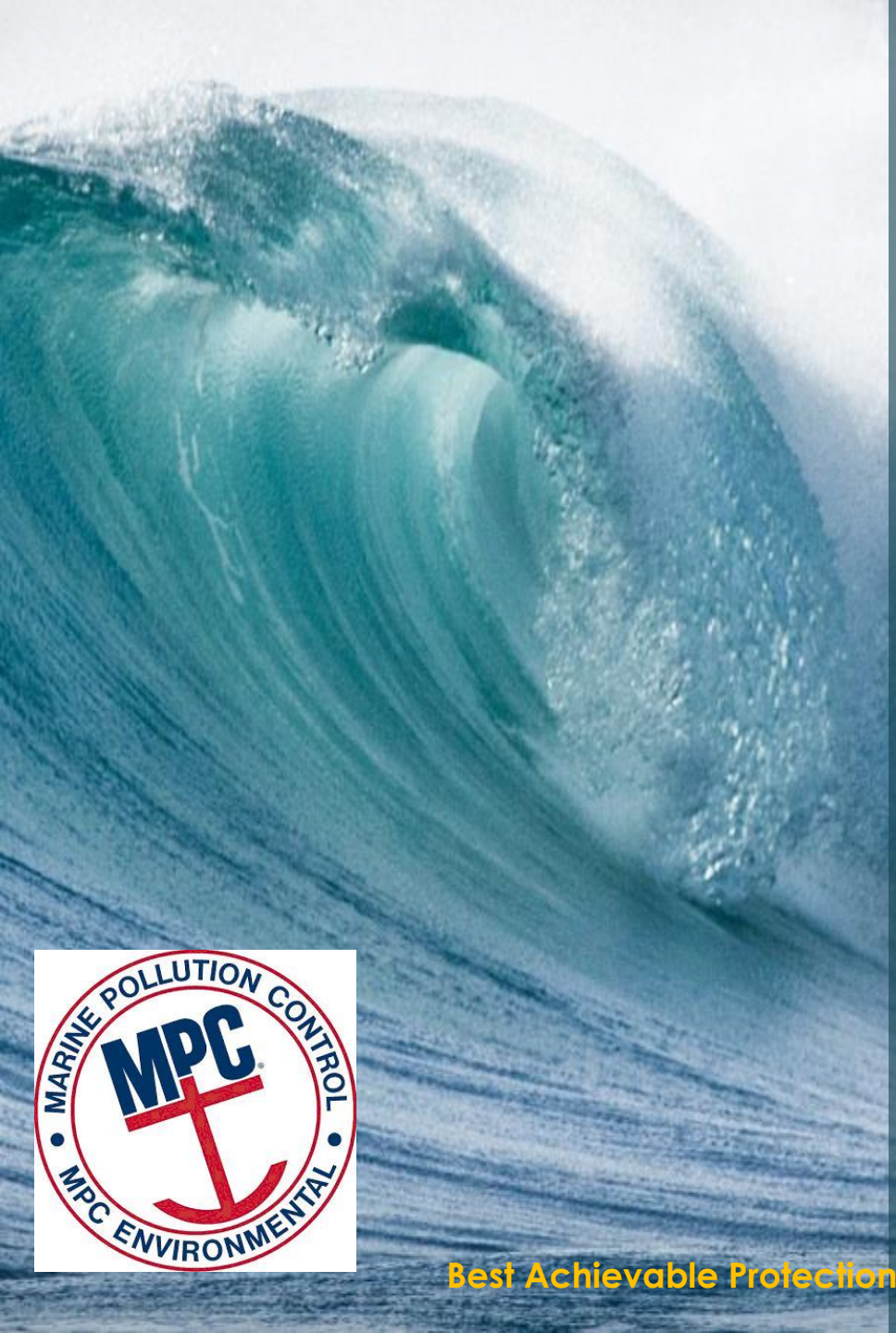

Incorporating Manned Submersibles into Submerged Oil Spill Responses: Detection and Recovery Strategies

David Usher
Bill Hazel
Marine Pollution Control – Detroit, MI

Best Achievable Protection Conference, Seattle, WA – May 21, 2015

Coal Tar Recovery Site – Detroit River - 1996

Coal Tar Recovery Site – Detroit River - 1996

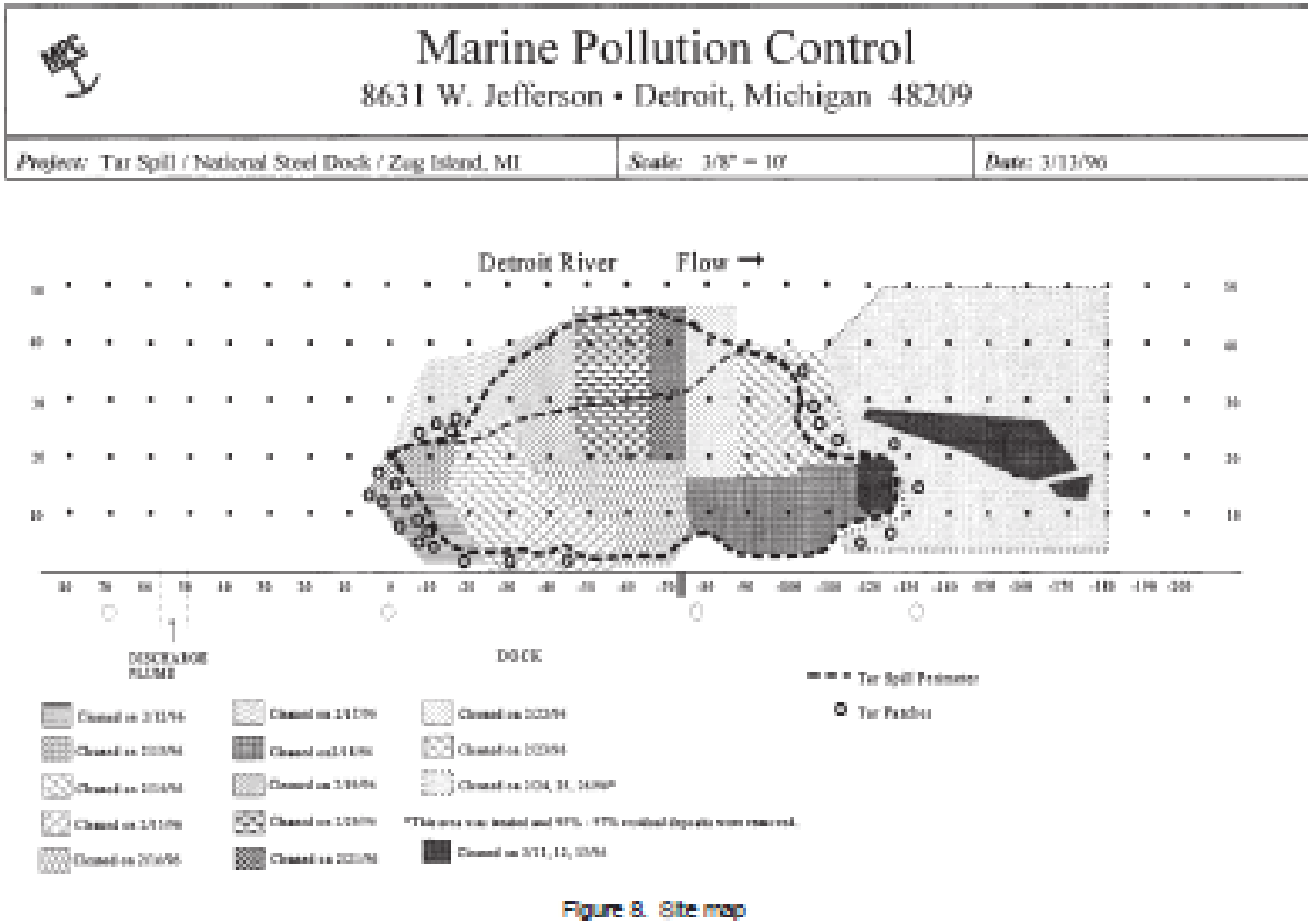

Figure 8. Site map

Coal Tar Recovery Site – Detroit River - 1996

Athos I Venezuelan Crude Oil Spill - 2004

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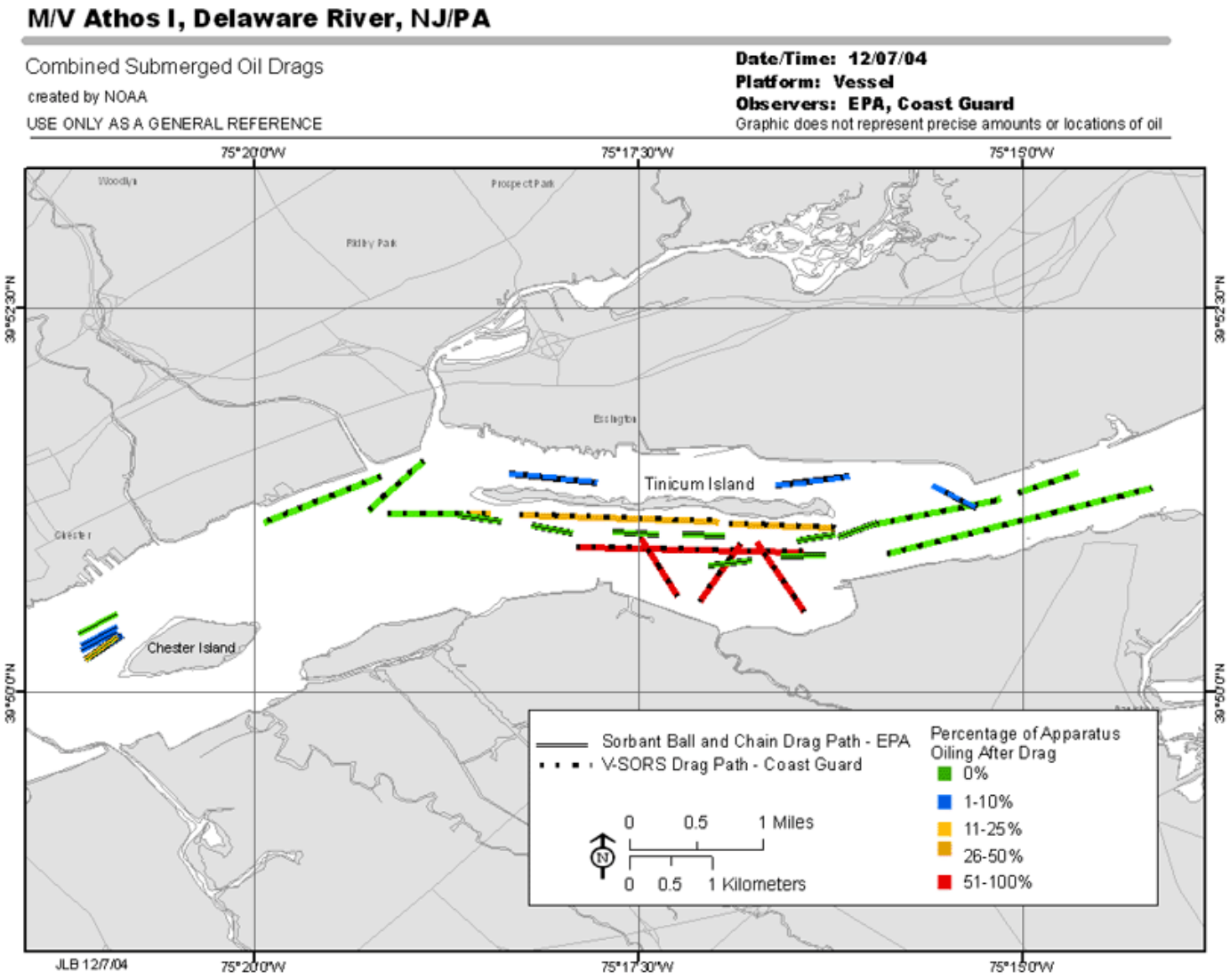
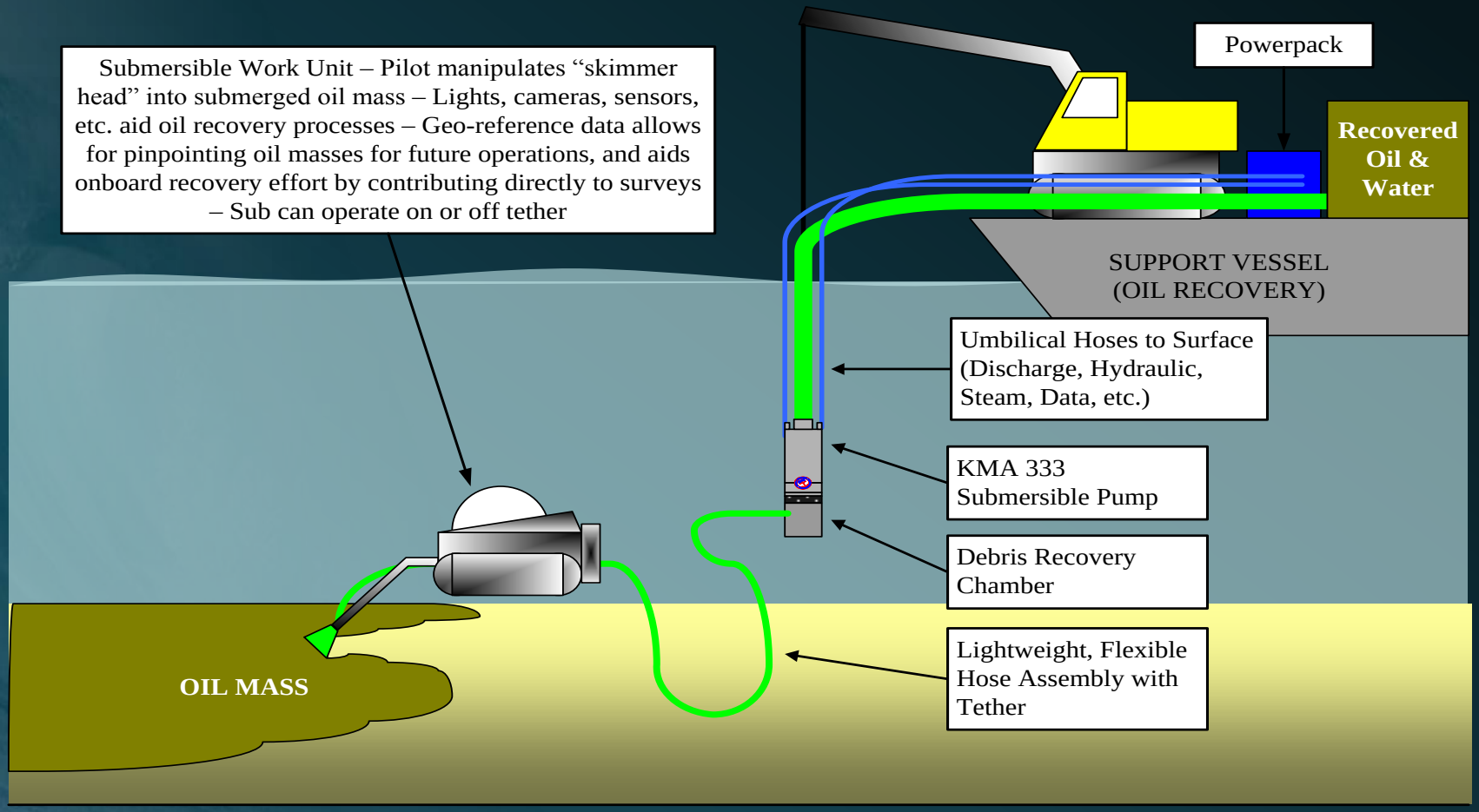


Problem Definition – Submerged Oils

- Complex environmental and spill fate considerations - two dimensional model vs. three dimensional model
- Reliable detection technologies still in development - data processing and analysis in real time conditions lags (Common Operating Picture)
- Determining the oil budget to accurately determine trajectory and fate plays a key role
- Recovery methods are complex and expensive – critical need for reliable and rapidly acquired and processed data will support improvements to tactical strategies
- **There is a need for a comprehensive and integrated approach to the problem to improve efficiencies**

Manned Submersible Submerged Oil Recovery Concept



Marine Pollution Control
8631 W. Jefferson
Detroit, MI 48209
313.849.2333 (ph)

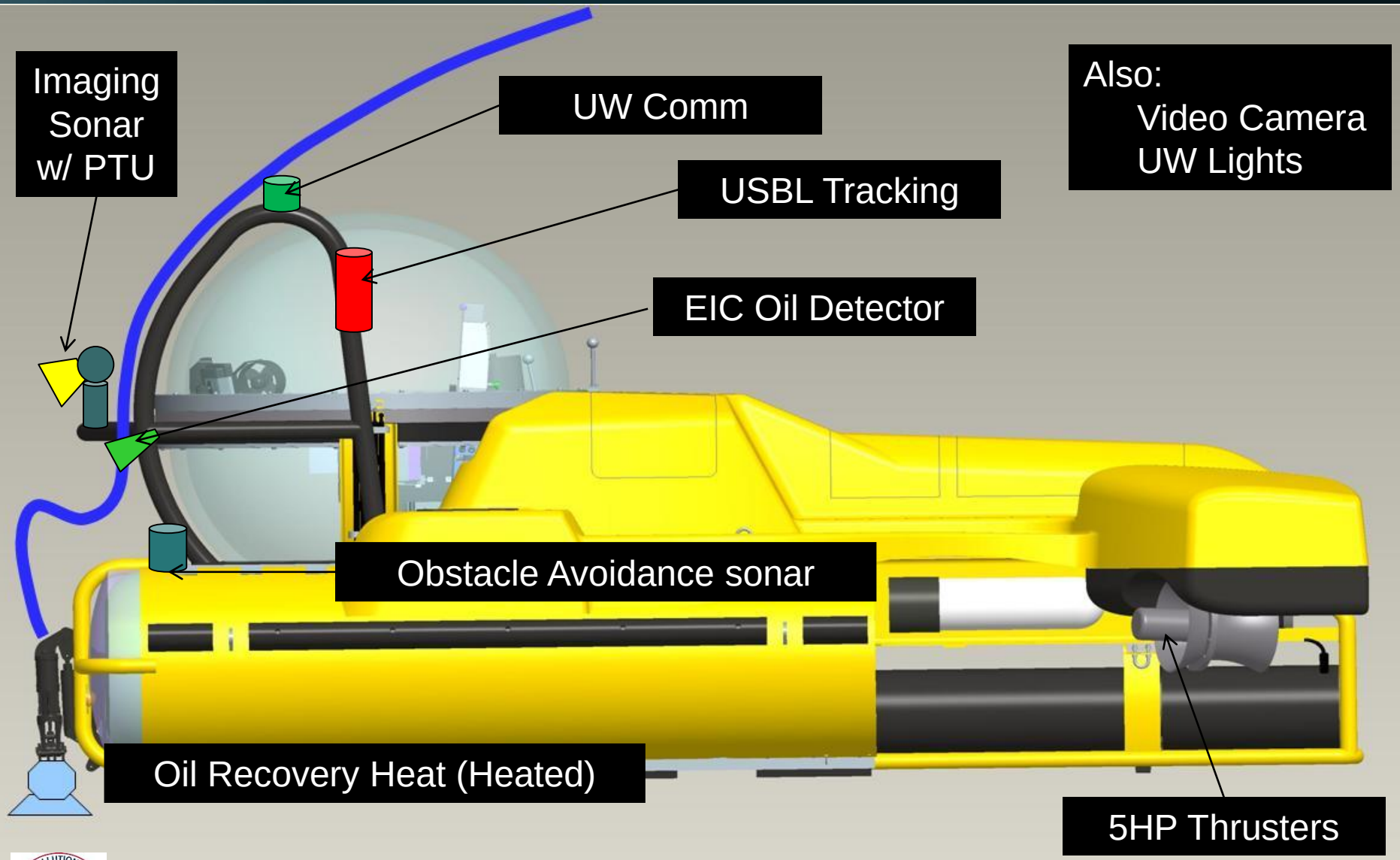
Diagram #1 - Draft General Concept Drawing:
Subsurface Oil Recovery Utilizing Manned Submersible Unit

US Patent 7,597,811
Canadian Patent 2,670,900

Ref: Sub Oil Recovery Sys.
Drawing: 1 of 1
Date: 08/07/09
Author: David Usher
Contact: (313)849.2333 (office)

Best Achievable Protection Conference, Seattle, WA – May 21, 2015

Integrated System based on Manned Submersible

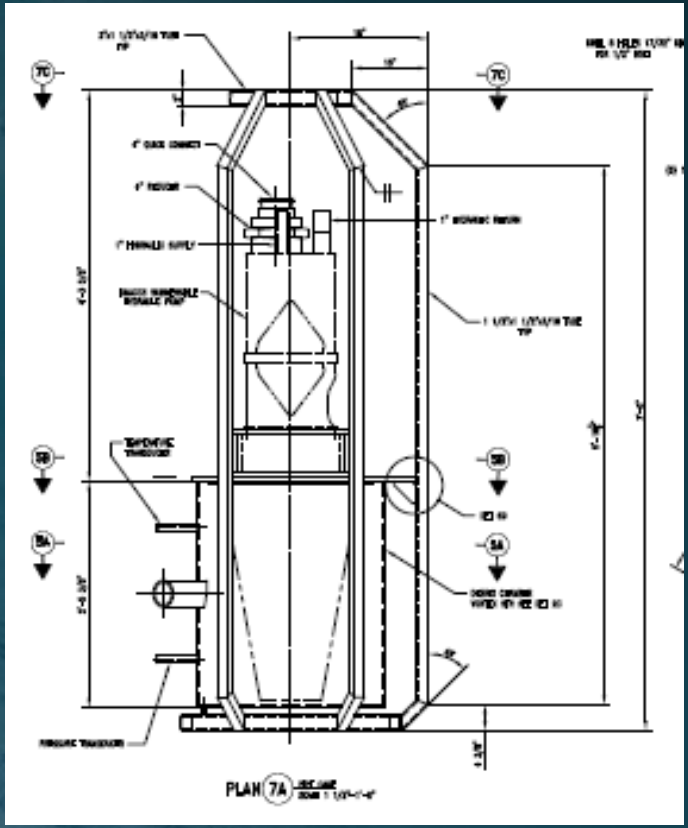


Integrated System based on Manned Submersible

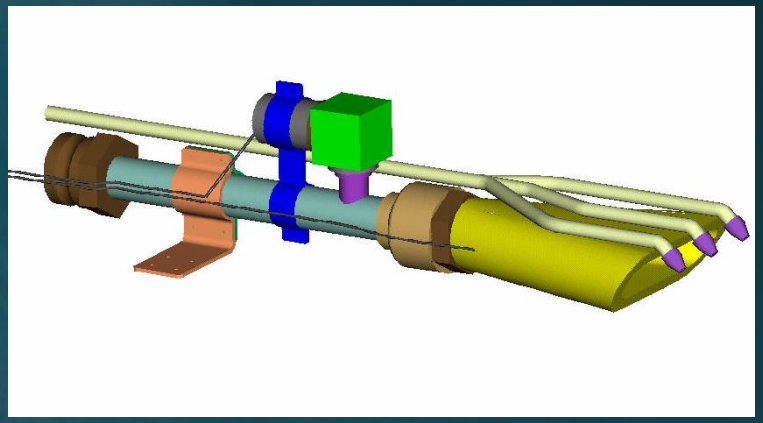
Submerged Oil Recovery System
Marine Pollution Control
Detroit, MI

- Suction-based hydraulic pump system outfitted with specialty suction head
- Vortex enhancing debris management system
- 200+ feet depth capacity
- Heavy oil capability
- Robust pump design allows solids up to 2.5 inches to pass
- Hardened construction – salt or freshwater operations
- Designed and containerized for rapid deployment and sustained remote operations
- Remote telemetry incorporated into umbilical system
- Can be deployed via multiple logistic platforms

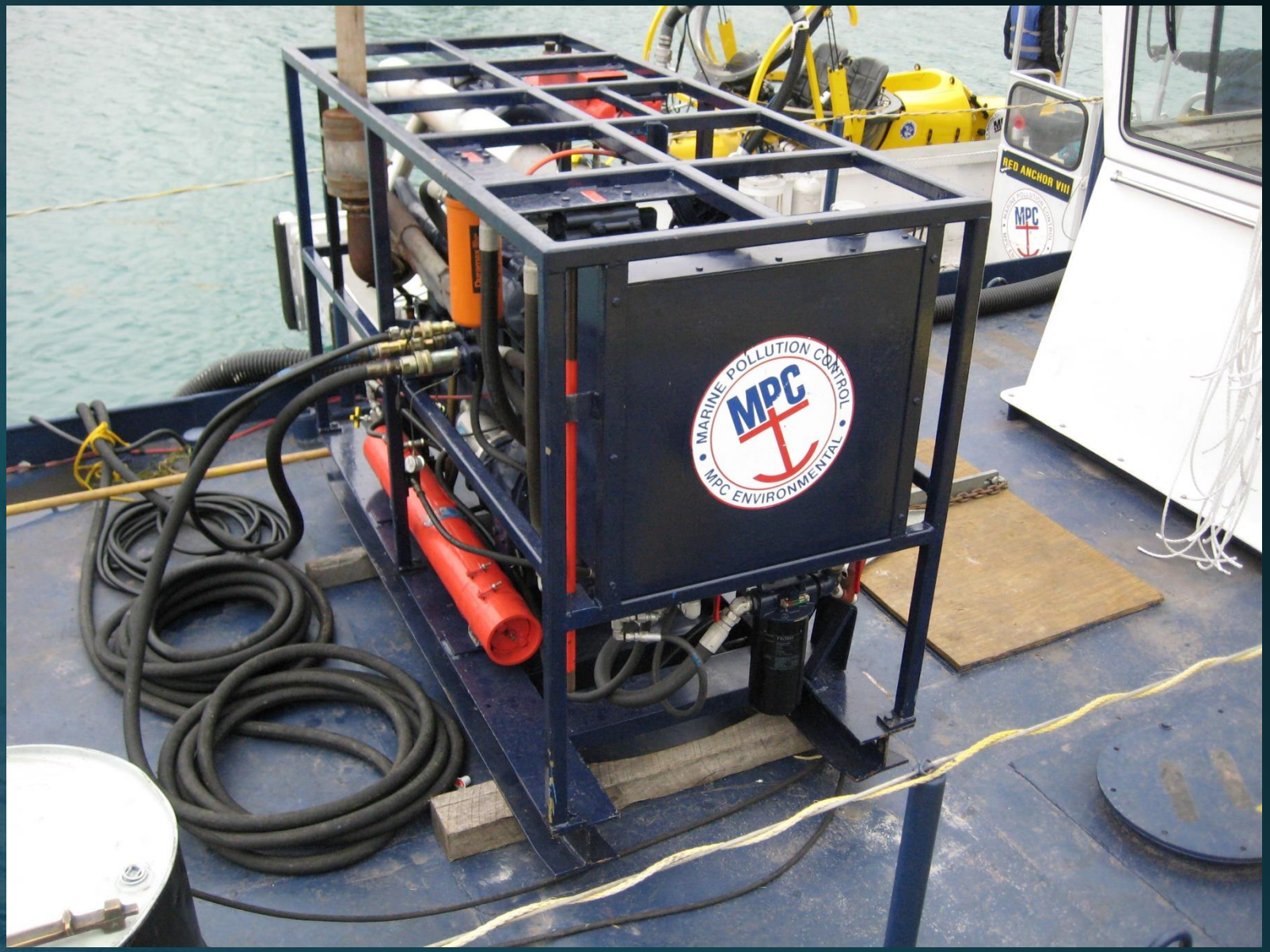
Submerged Oil Recovery System



Submerged Oil Recovery System



Submerged Oil Recovery System



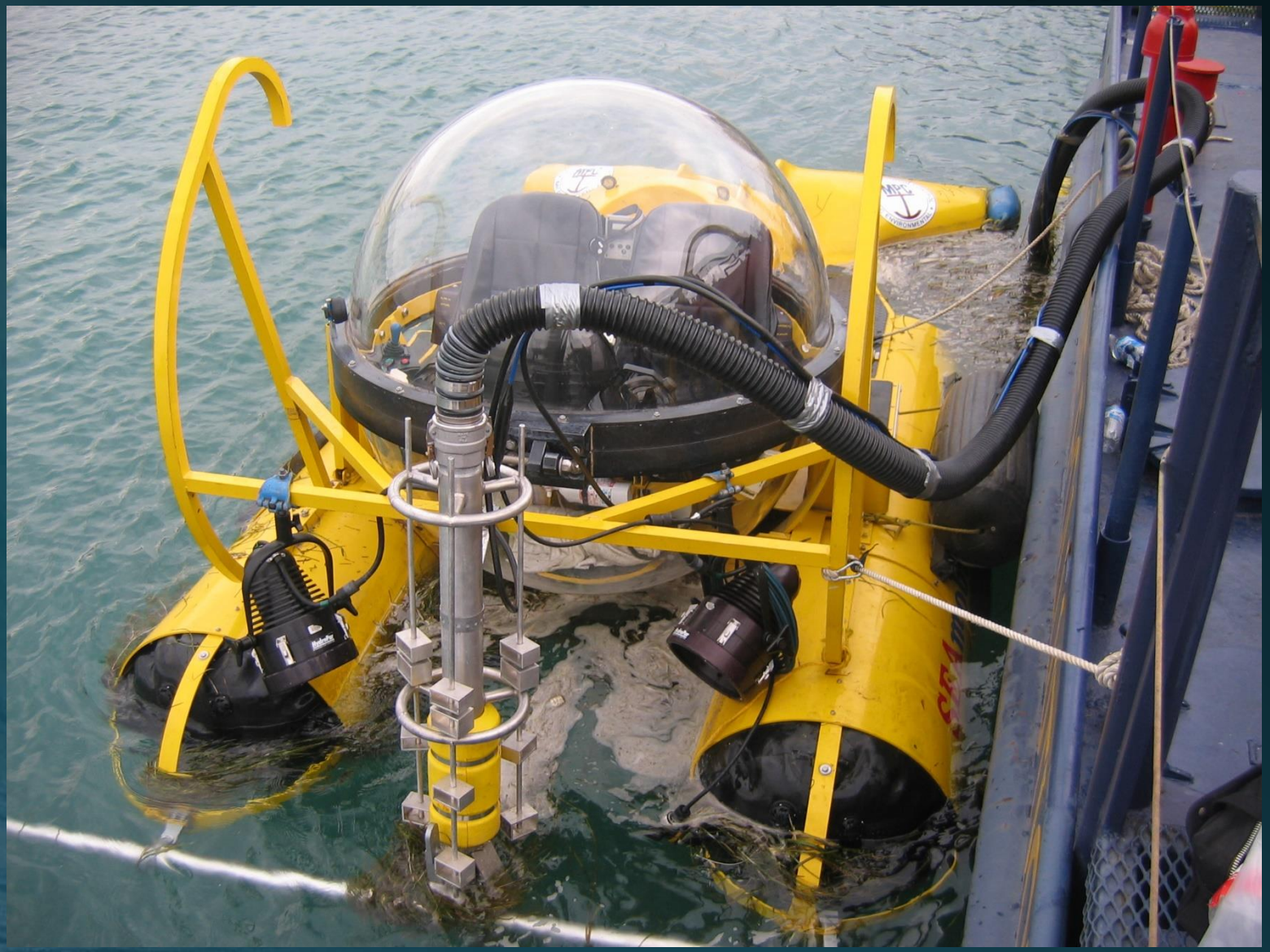
Manned Submersible Unit

SEAmagine Hydrospace Corporation Claremont, CA

- Founded in 1995
- All SEAmagine submersibles undergo full ABS or DNV-GL approval
- Over 12,000 dives with perfect safety record
- 150M to 1000M depth capability
- 6-7 hours operation on battery – can tether to extend
- 2-person model supports oil recovery operations
- Subsurface sonar navigation/avoidance– advanced robotics – enhanced hi-definition video
- Interfaces with MPC subsurface oil recovery system and advanced oil detection and mapping technologies

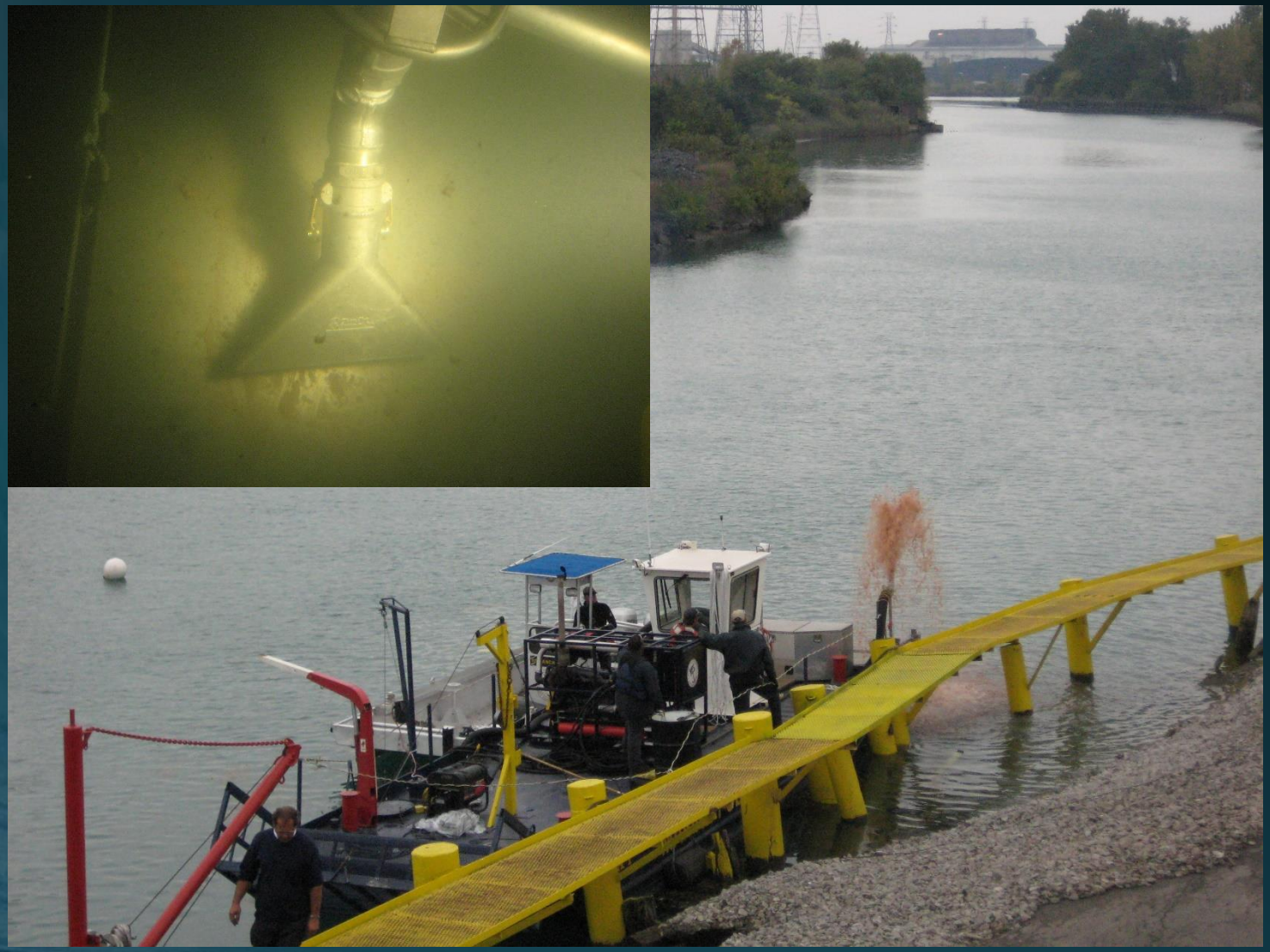
Manned Submersible (Freshwater Field Tests Detroit)

Submersible Outfitted with MPC Recovery System



Manned Submersible (Freshwater Field Tests Detroit)

Manned Submersible (Freshwater Field Tests Detroit)



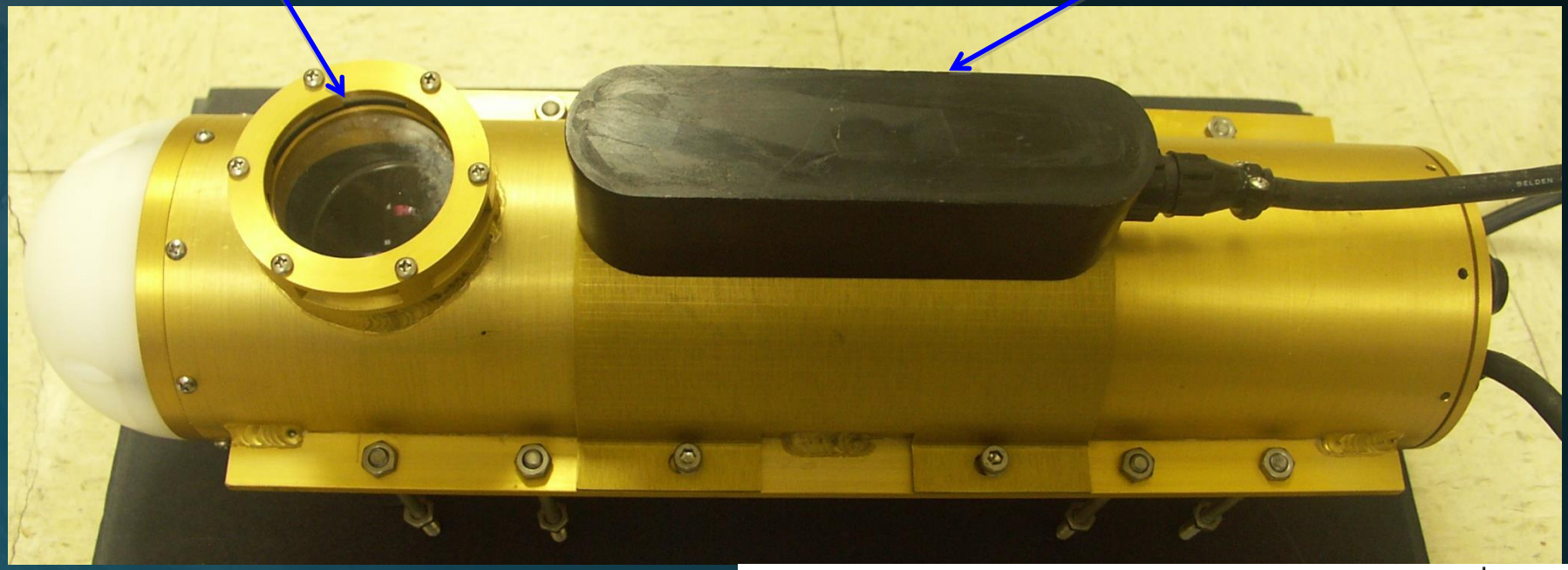
Aurora Manned Submersible (Newest Generation)

Fluorescence Polarization

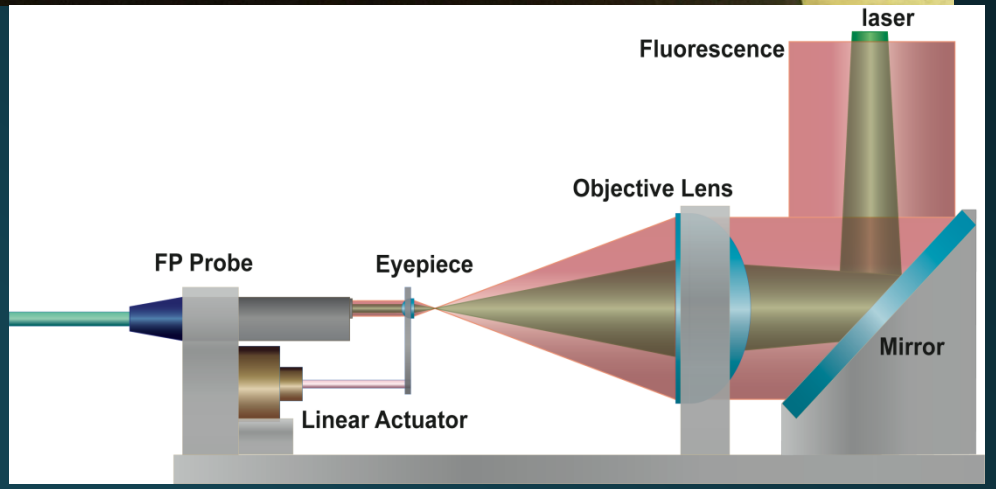
EIC Laboratories, Inc.
Norwood, MA

- US Patent 7,728,291
- Because the main constituents of oils are aromatic compounds, illumination of oil samples with ultraviolet and visible light causes the oil samples to emit fluorescence
- Advantages include that the detection method is non-contact and easily miniaturized
- FP can be used to selectively differentiate heavy oil fluorescence from other fluorescing species in seawater, such as chlorophyll that most likely will not show fluorescence polarization
- Oil detection in turbid media or murky environments is problematic, however, it can be accomplished by positioning the FP instrument at a standoff distance closer to the target area

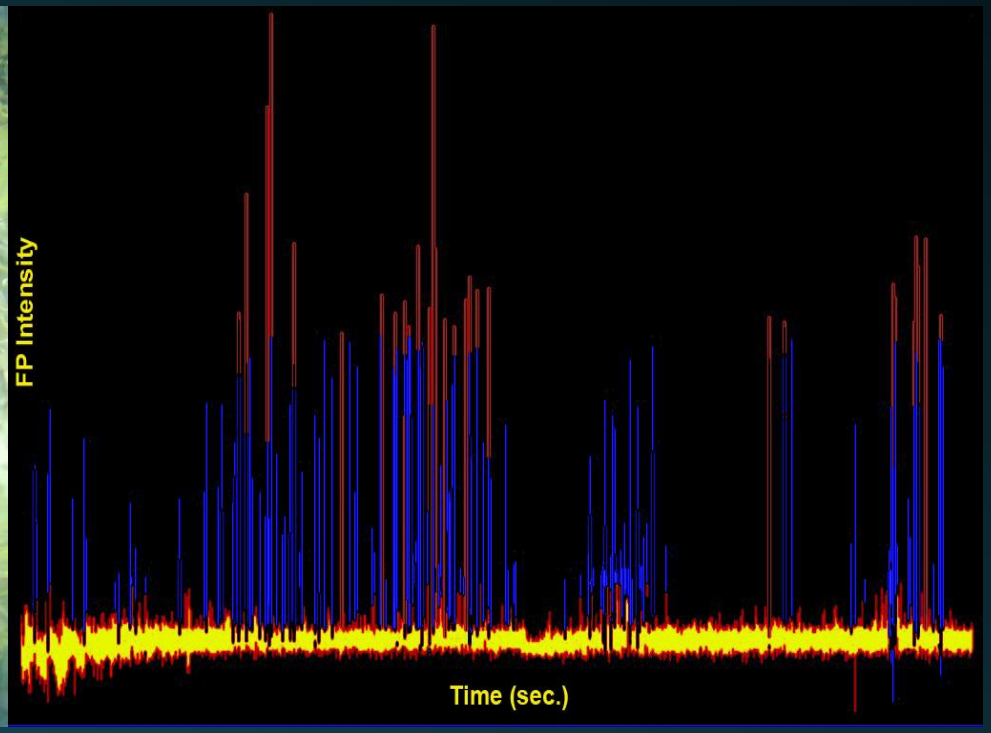
Auto-Focusing Fluorescence Polarization (FP) Instrument



- Telescopic focusing and detection
- Embedded computer
- Can be autonomously or remotely operated
- Serial communication
- 30 W power requirement
- 20.25” L x 4.26” D



OHMSETT Testing of Integrated Detection and Recovery Systems

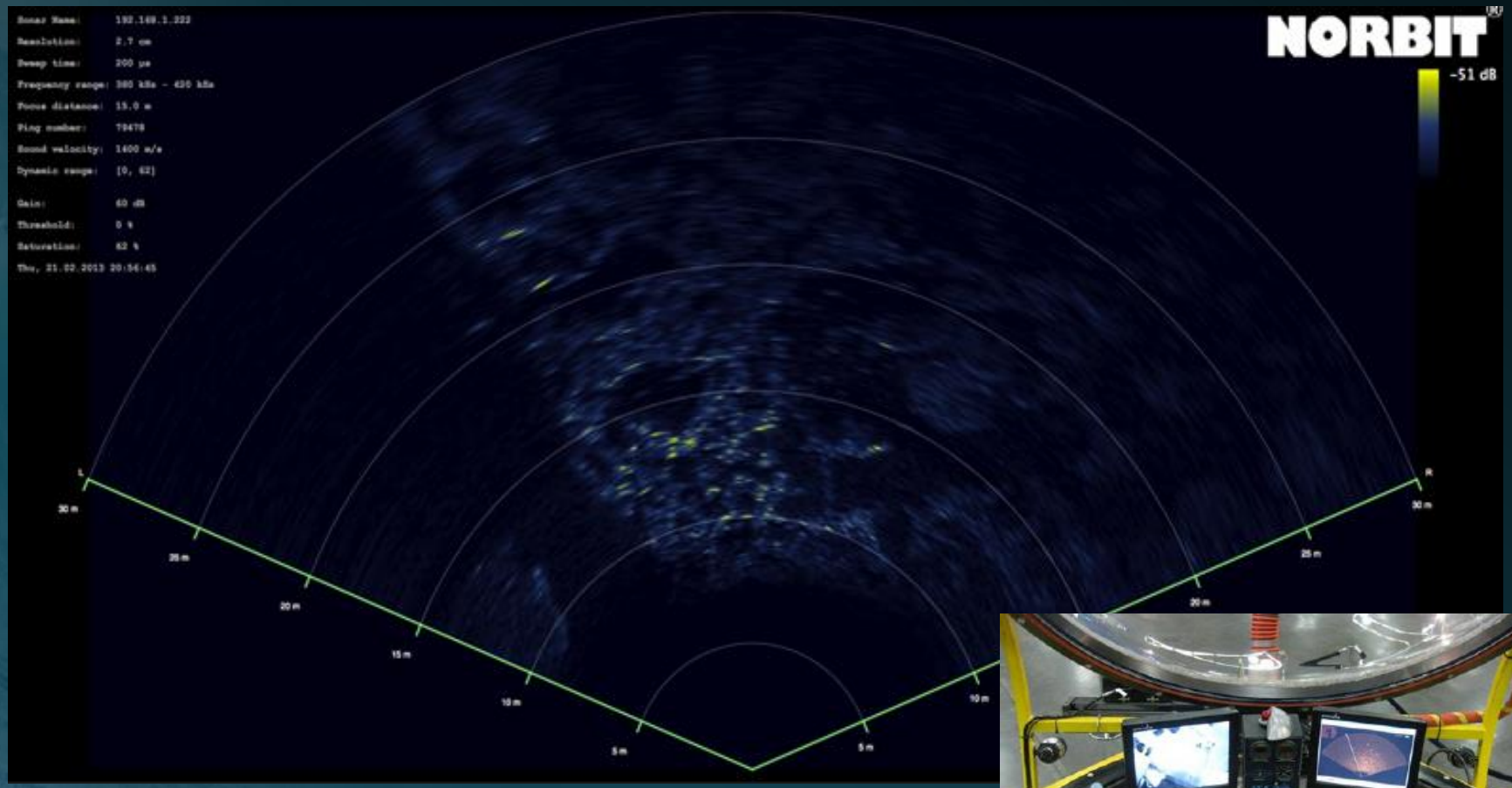


Multi-beam Sonar

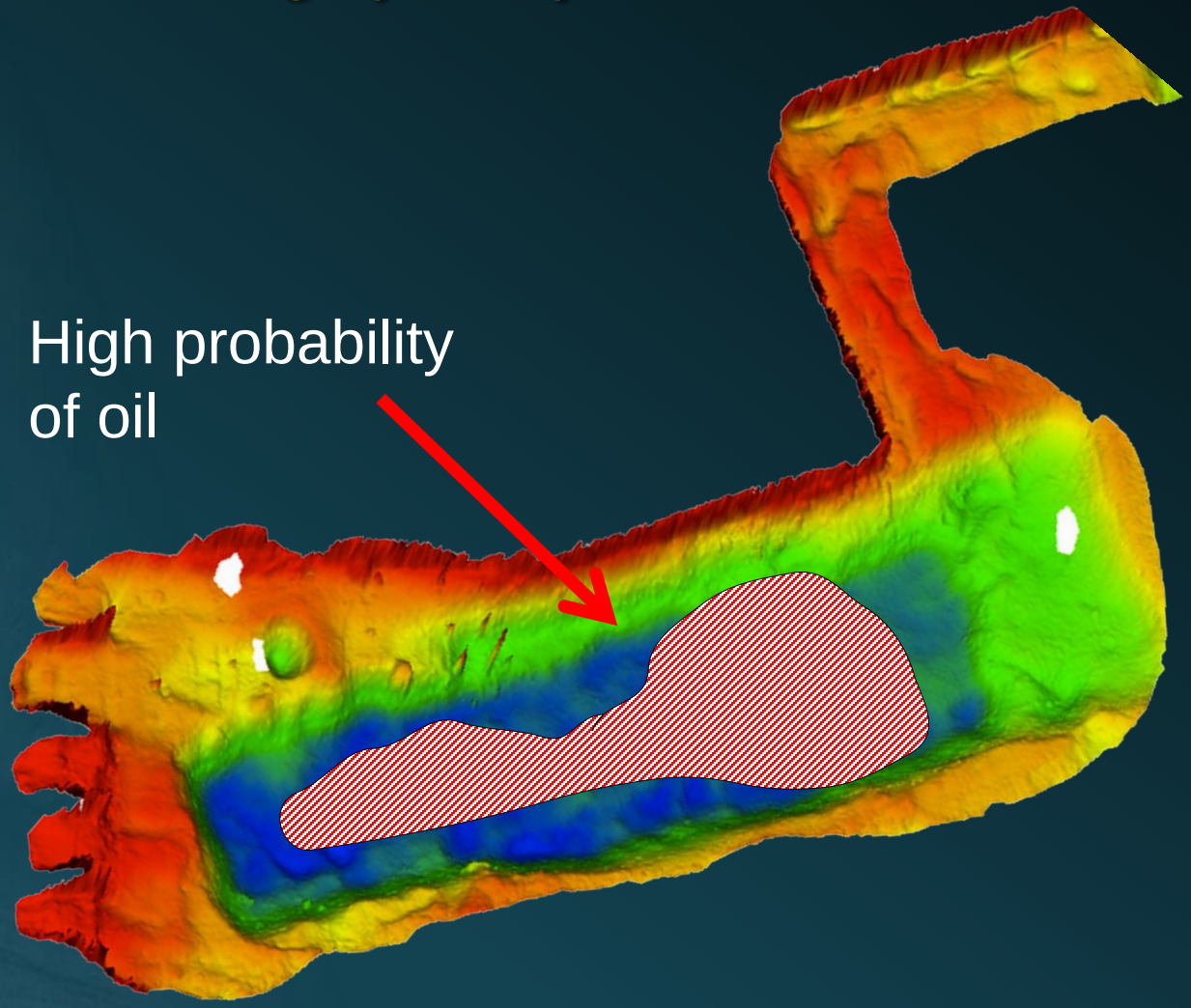
Norbit Group AS - Trondheim, Norway
Norbit US Ltd – Santa Barbara, CA

- Modern active acoustic multi-beam sonars have achieved major breakthroughs in terms of performance, physical size, power consumption, uplink flexibility, processing and price.
- This now allows the tool to be used in a much wider context during subsea hydro carbonate (Oil/gas) detection, quantification and visualization. Advanced processing systems such as Geocoder allow for bottom surface characterization including potential oil discrimination capacity.
- Flexibility of these devices enable them to be easily integrated to various platforms including AUVs, MUVs, ROVs, gliders, towable arrays, permanent installations, ship borne platforms, etc.

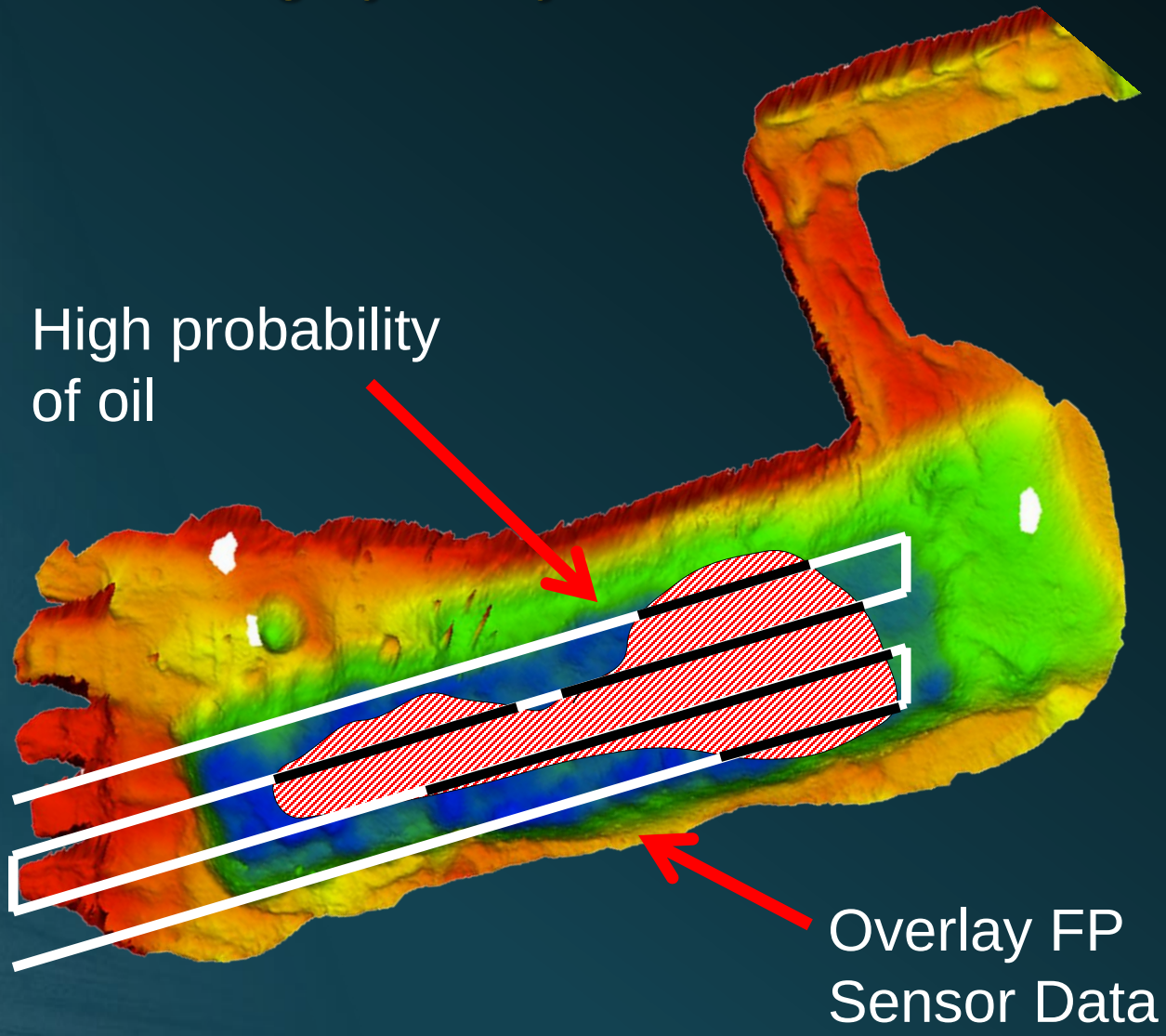
Real Time Sonar Imagery Capture



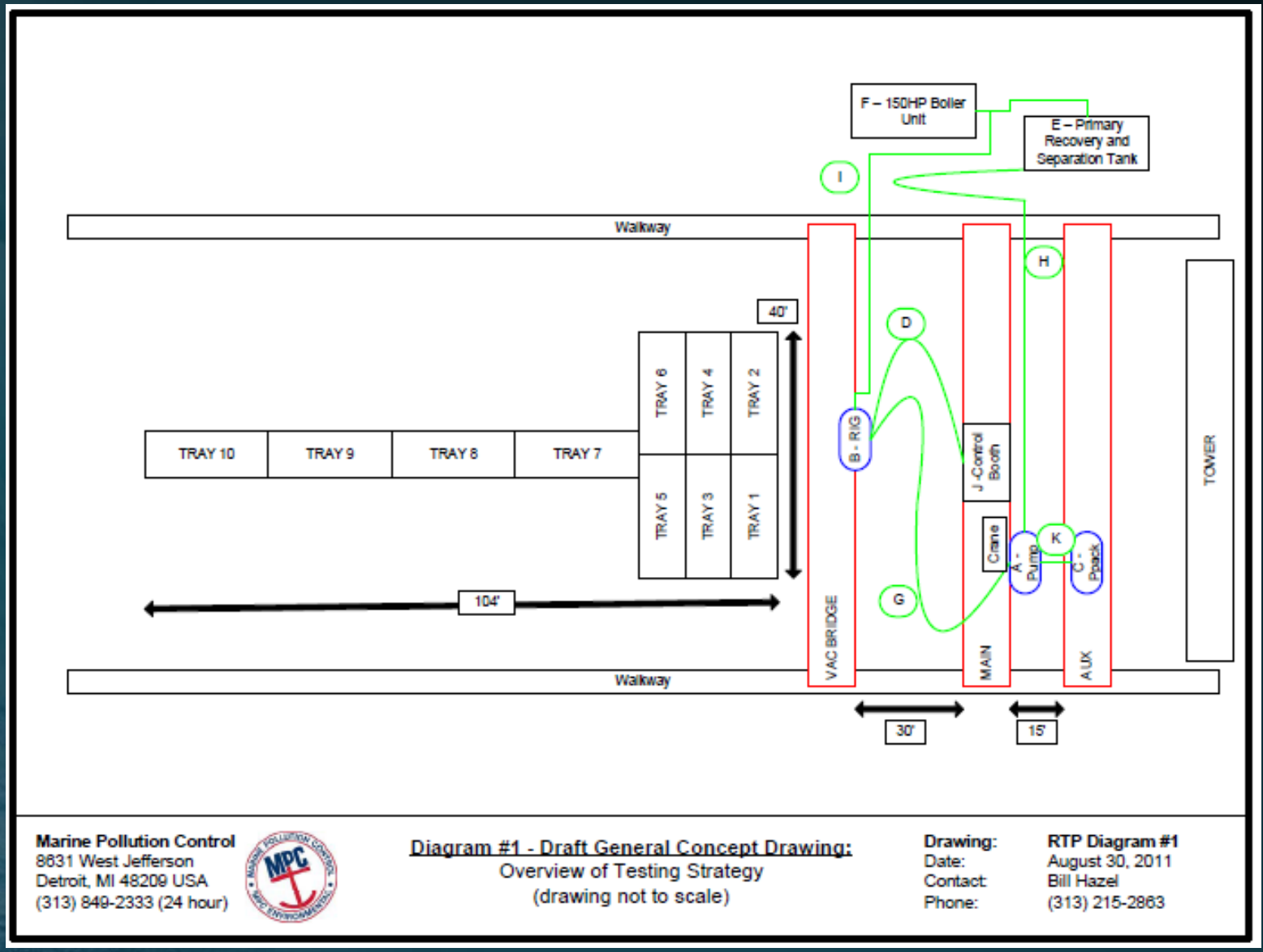
Processed Sonar Imagery Bathymetric Mosaic



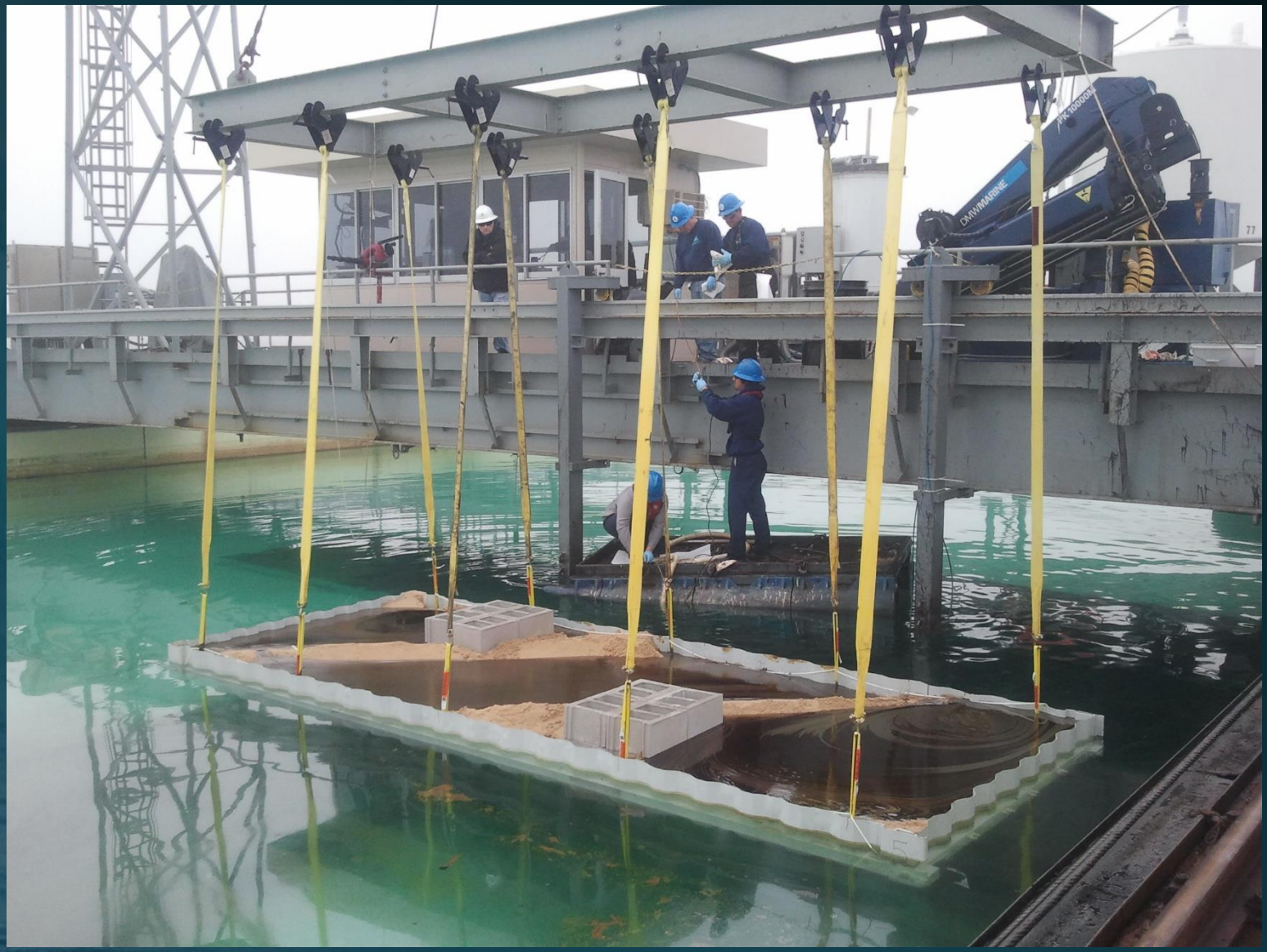
Processed Sonar Imagery Bathymetric Mosaic



USCG R&D Prototype Tests at OHMSETT - 2011



USCG R&D Prototype Tests at OHMSETT - 2011



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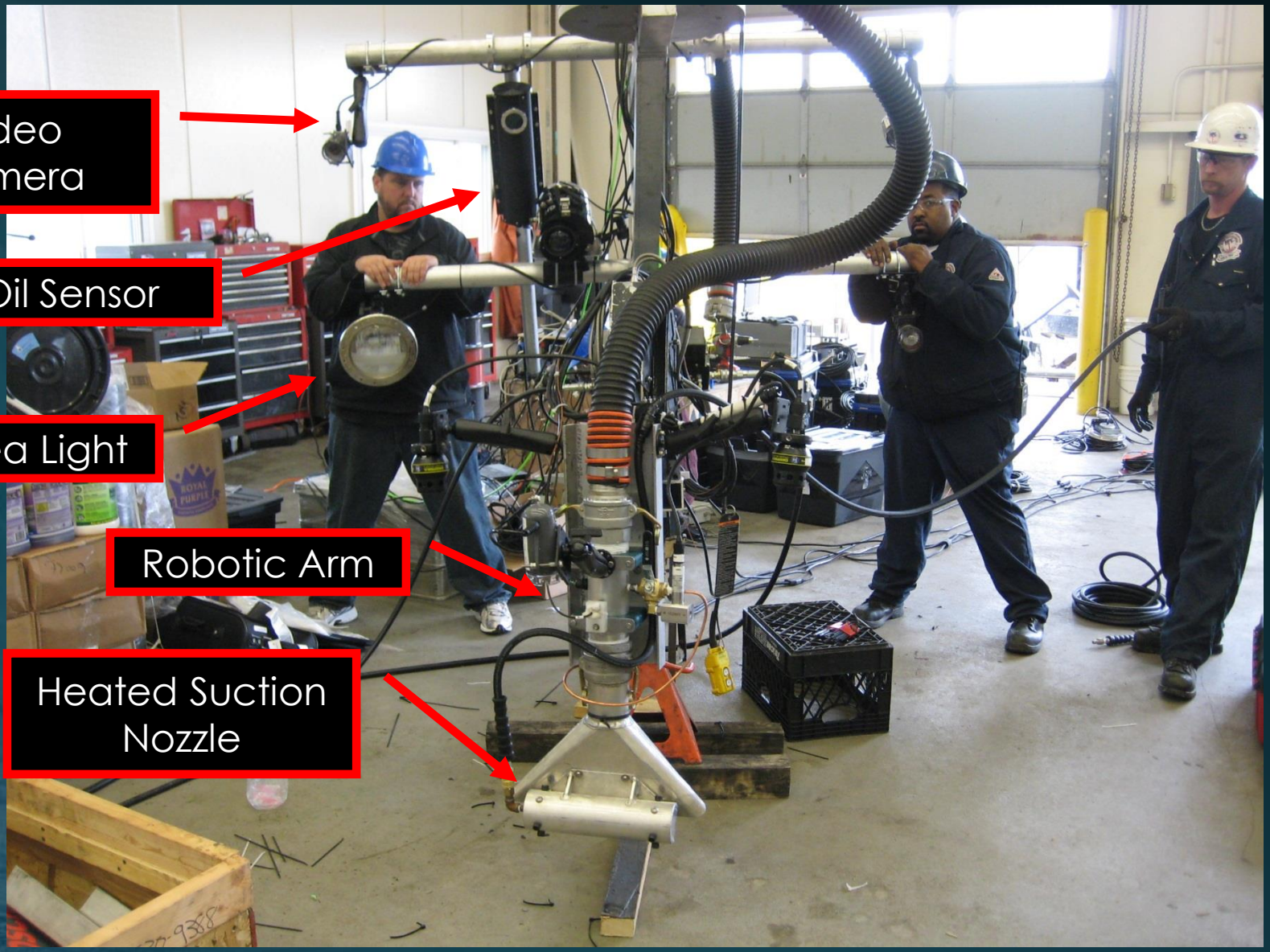
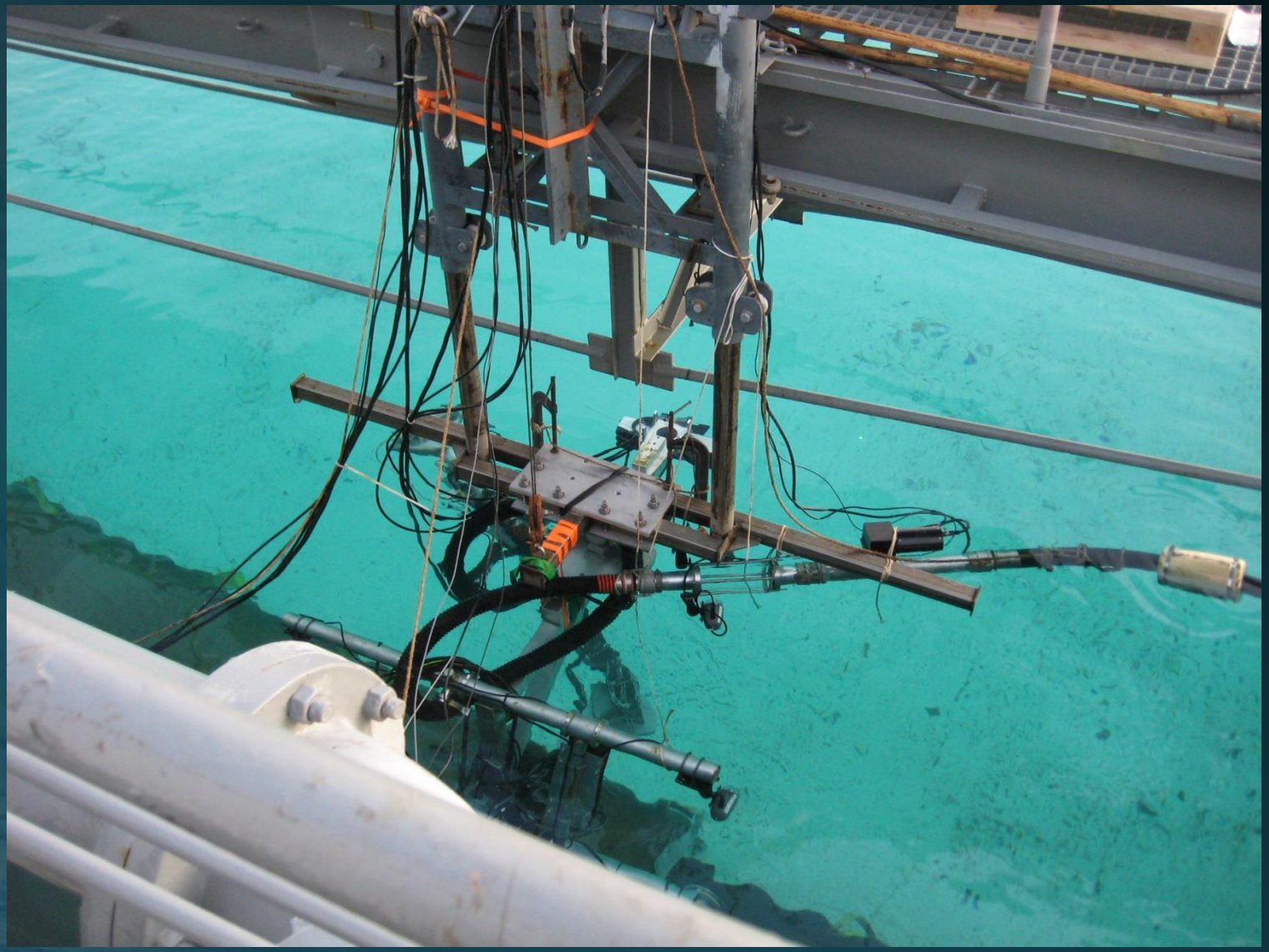


USCG R&D Prototype Tests at OHMSETT - 2011



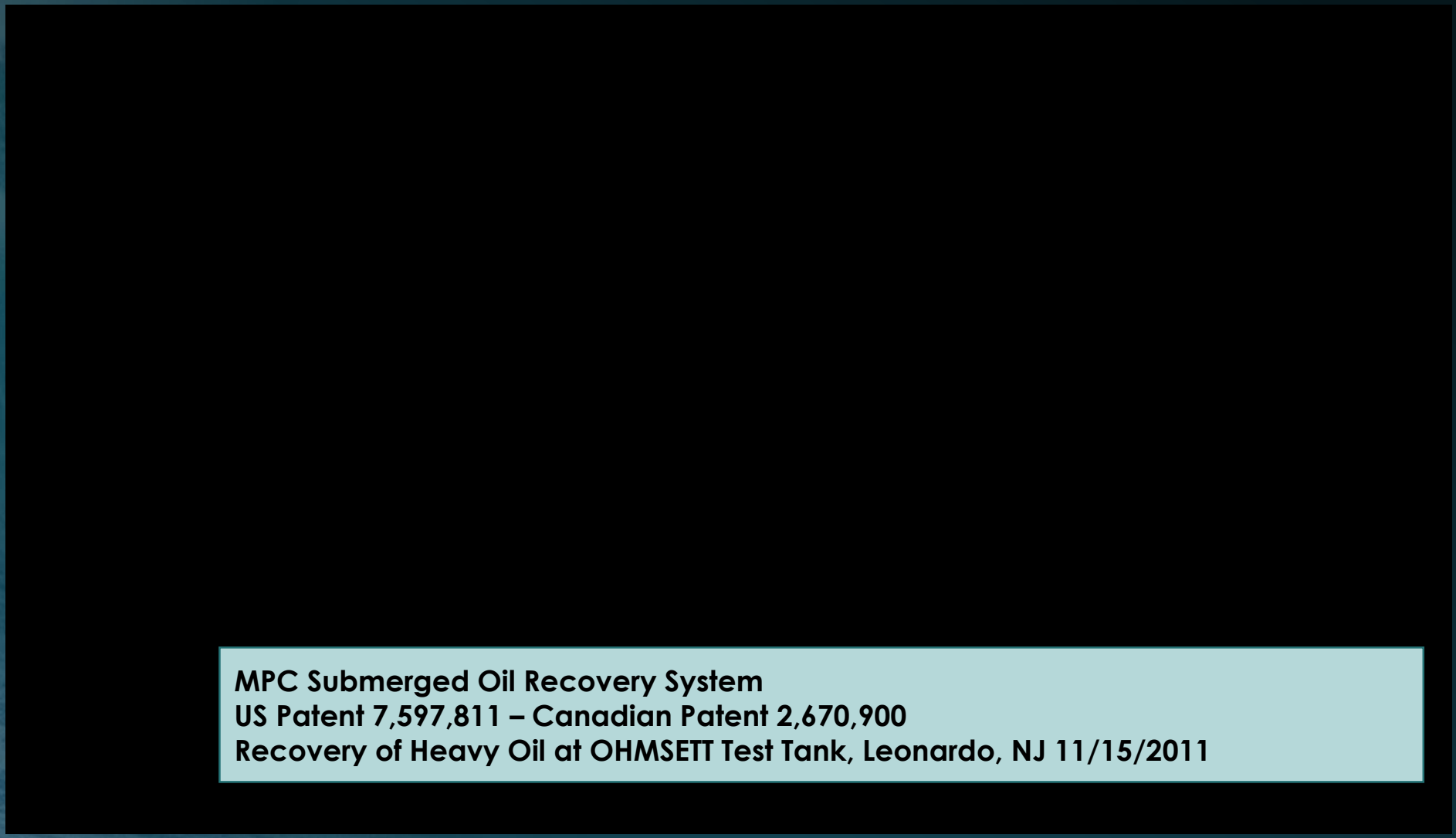
Video - Top-Side Operations at OHMSETT

Video - Top-Side Operations at OHMSETT

Video - Top-Side Operations at OHMSETT

Video - Top-Side Operations at OHMSETT

Video - Subsurface (Tank) Operations at OHMSETT



MPC Submerged Oil Recovery System
US Patent 7,597,811 – Canadian Patent 2,670,900
Recovery of Heavy Oil at OHMSETT Test Tank, Leonardo, NJ 11/15/2011

Thank You for Your Attention