Non-Floating Oil Spill Workshop

A special meeting of the

Technical Advisory Committee

November 15, 2017

Summary prepared by the California Department of Fish and Wildlife, Office of Spill Prevention and Response

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CONTENTS

INTRODUCTION

California's Lempert-Keene-Seastrand Oil Spill Prevention and Response Act established the Oil Spill Technical Advisory Committee (TAC) to provide for public input and independent judgment of the actions of the Administrator of the Office of the Spill Prevention and Response (OSPR).

The TAC provides recommendations to the Administrator, the State Lands Commission, the California Coastal Commission, the San Francisco Bay Conservation and Development Commission, the Division of Oil, Gas, and Geothermal Resources, the Office of the State Fire Marshal, and the Public Utilities Commission, on any provision of the Act, including the promulgation of all rules, regulations, guidelines, and policies. (Ref. Government Code §§8670.54 – 8670.56.1)

On November 15, 2017, OSPR hosted a multi-agency informational meeting for the TAC with the goal of providing a forum addressing the state's risk of and readiness to respond to spills of Non-Floating Oil (NFO). Subject matter experts presented information describing the types, current use, trends, and transportation of NFO in California, the fate and transport of NFO when spilled in different environments, the ecological impacts of NFO spills, and the available technologies to detect and recover spilled NFO.

Five response questions framed the workshop:

- **What might be spilled?** – Which NFOs are being shipped within California, where, in what volumes, and by what method (ship/barge, pipeline, rail)?
- **Where will it go?** – What affects oil fate & transport of different NFOs? Can they be reliably detected? Can we predict transport using trajectory models?
- **What might get hit?** – What sensitive resources might be in the path of submerged or sunken oil?
- **How will it hurt?** – What effects might we expect from NFOs on sensitive resources?
- **What can we do about it?** – What tools are available to contain and recover NFOs effectively and minimize additional response-related impacts?

To answer these questions, a selection of subject matter experts was invited to speak, and a moderated discussion was held. Attendees of the public meeting included appointed TAC members and representatives from the California Energy Commission, United States Coast Guard (USCG), National Oceanic and Atmospheric Administration, OSPR, and the response contractor community.

The meeting agenda and one-page summaries from each talk are attached. A video recording of the workshop and copies of each presentation can be found on the OSPR website: https://www.wildlife.ca.gov/OSPR/Public-Meetings/Technical-Advisory-Committee/Non-Floating-Oils

PRESENTATIONS

What might be spilled?

Gordon Schremp of the California Energy Commission's Energy Assessments Division provided a presentation that outlined the transportation of oil and petroleum products throughout the state. California is a significant crude oil producer, though production has dropped steadily over the last two decades and is currently at the lowest production volume since the 1930s. California imports crude oil from global sources primarily in North America, the Middle East, and South America. Two thirds of the crude oil received by refineries comes by vessel; the rest comes from pipelines and rail. Due to increased pipeline capacity, shipments of crude oil by rail have decreased. California had no Canadian crude oil imports with API gravity of less than 10 in 2016; all Canadian crude imports were lighter than water, though some were heavy crudes blended with diluents. Crude oil shipped to and within California is usually a blend of heavy and light oils, creating unique sets of characteristics. Safety Data Sheets (SDSs) for crude oil are often generic and additional characterization data may be necessary for response. The Energy Commission receives data regarding what is being shipped, the volume, and its destination, but specific information such as American Petroleum Institute (API) gravity is not provided.

Where will it go?

Jordan Stout, Scientific Support Coordinator from the National Oceanic and Atmospheric Administration (NOAA), described the properties and behaviors of NFOs when released to the environment. Different types of oil may sink or become suspended in the water column due to a number of factors. Some crude oils are more dense than water, and will naturally sink; others that would normally float on water, may mix with sediment or change characteristics due to weathering (e.g., evaporation of the light components), and then suspend or sink in water. The water temperature, turbidity, current, and salinity all affect the likelihood of the oil to suspend or sink. As these conditions change, NFO may refloat and may sink again. In addition to the density of the oil, the viscosity and persistence of the oil are critical characteristics to consider during spill response.

Chris Barker, also of NOAA, discussed tools for trajectory analysis during oil spills and the fate of spilled oil. He pointed out the differences between predicting the transport of spills on the surface and spills of NFO. Modeled trajectories for NFOs come with much more uncertainty. Instead of relying on wind and surface currents that are comparatively easier to accurately measure, a modeler must look at oil droplet size, undercurrents, and viscosity when predicting fate and transport of NFO. Because NFO spills are rare, responders have less experience to guide their analyses and expectations.

Jacqui Michel of Research Planning, Inc., addressed the detection of NFOs when spilled. For sunken oils (oils on the bottom of a water body), she highlighted the use of sonar, visualization/cameras, sorbents, bottom sampling, underwater laser fluorescence, and diver observation. Options for suspended oil include water column sampling, acoustic sensors, fluorometry, optical scattering, and induced polarization. No one detection technology is effective for all NFO spill situations. Each of the technologies presented have advantages and constraints associated with water visibility, depth, the bottom substrate type, the size and/or thickness of the spilled oil patch, the ecological sensitivity of the benthic habitat, survey coverage rates, and data processing needs. Because there have been few NFO spills in the U.S., these technologies have not been widely used for spill response, and additional testing and protocol development is recommended. Additionally, some of the equipment is expensive and quite specialized, and as such, may not be readily available throughout California, and would need to be shipped for spill response.

What might get hit?

OSPR's Kathleen Jennings gave a summary of the types of ecological resources/organisms at risk of injury from sunken and submerged oil. Freshwater and marine water column species, benthic fish and invertebrates, and their habitats would potentially be exposed to oil in an NFO spill. Specialized habitats such as riffles and pools, and salmon redds may be at risk. Ecosystem wide effects would be expected from exposure to any given species or habitat due to the interconnectedness of all system components. In addition, use of NFO spill clean-up methods at the bottom of a waterbody can also pose a significant threat to these resources.

How will it hurt?

April DaSilva, also of OSPR, provided a talk that outlined NFO toxicity and the mechanisms by which resources are impacted by oil below the surface. April presented several case studies, demonstrating how different conditions change the expected behavior and associated toxicity of NFO. Key risk factors specific to NFO include accumulation of persistent oil in the benthic environment and slow long-term release of water soluble PAHs. Resulting impacts include chronic toxicity effects (e.g., mortality, developmental impairment, carcinogenicity), and the smothering/coating of organisms and/or their gills. Indirect impacts include changes in suitable spawning habitat, reduced food sources and trophic disruption, and other critical life cycle resources.

What can we do about it?

Kurt Hansen, of the US Coast Guard (USCG), described containment techniques for suspended oil. Current tools include the use of snares, sorbents and specialized netting, and forcing oil to the surface with air bubbles. He also discussed various detection strategies, the limitations of testing containment techniques in a closed environment, and the issues of entrainment and decanting.

Continuing this topic, Jacqui Michel addressed the advantages and disadvantages of various sunken oil containment and removal tools and techniques. Containment tools available include bottom half curtains, bottom filter fence cages filled with looped sorbents, full height curtains, berms, trenching, and enhanced natural collection areas.

Collection and recovery tools include the suction dredge, diver-directed pumping, clamshell and “environmental clamshell” dredging, bucket excavators, sorbents, nets, hand-tool removal (in shallow water), and agitation/re-floating for surface recovery. NFO spills are complex, and the response technology may require a custom design. Other factors to consider are decanting, storage, and disposal of the large volume of oily water generated with most techniques.

Mark Gregory, USCG, prepared a talk addressing federal regulations and Oil Spill Response Organization (OSRO) certification for NFO. Federal regulations require plan holders to identify procedures and strategies for responding to a worst-case discharge of Group V (heavy) petroleum oils to the maximum extent practicable, and resources must be deployed within 24 hours of discovery of such a spill. The USCG’s OSRO Guidelines provide a classification of contractors specifically for NFO. Although Mark was unable to attend the workshop, his presentation and summary are available.

Jim Elliott, Vice President of T&T Marine Salvage, provided additional detail regarding the USCG’s rules and standards. His presentation addressed remote sensing, direct observation techniques and equipment, including specially designed systems for detecting NFO. He also described recovery and containment strategies and described the logistical and operational limitations and considerations for each approach.

DISCUSSION AND SUMMARY

The workshop concluded with a moderated discussion about California’s state of preparedness for spills of NFO.

Immediately upon initiation of spill response actions, assessment would be underway to determine the resources needed for detection, containment, and recovery. It is critical to know as much about the spilled product as possible as well as the receiving water. Response to a Class V sinking oil would immediately engage different equipment and tactics than for a spill of a lighter oil that may sink over time due to sedimentation. Products spilling from a pipeline are blends, so specifications from an SDS should always be validated with a source sample or more detailed information from the buyer or seller (the shipper may not have detailed information available).

Oil spill response trailers and OSRO facilities are primarily stocked for response to floating oils because these are much more common spills. Much of the equipment necessary for response to NFO is readily available (e.g., suction dredges, clamshell dredges, and excavators), but would be contracted by the OSROs at the time of the spill, potentially slowing down the response deployment time. Administrative requirements (e.g., contracts, sourcing, and delivery) for specialized equipment and personnel should be established ahead of time to the extent feasible to minimize deployment time.

Recommendations discussed by the group included the development and implementation of deployment drills and table-top exercises for NFO spill scenarios in various locations in California (inland and marine settings). The exercise should address local response resources, including partnerships among OSROs. These will help identify subject matter experts, permit issues, equipment issues, sensitive habitats, hydrological data sources, and other important information. As always, preparedness and advance training will maximize the effectiveness of a response. Having this data up front for our highest risk areas, instead of acquiring it during a spill, would be advantageous. OSPR is currently developing Geographic Response Plans for inland waters that will provide some of the key information. In addition to drills and exercises, NFO response training is recommended to ensure that the response community (i.e., OSROs, potentially responsible parties, the regulatory community, and other stakeholders) is optimally prepared for NFO spills. Because NFO spills have been rare, the response community has less experience with the various tools and strategies to detect, contain, and recover NFO than with floating oil.

Additional research topic recommendations included:

- Weathering of various petroleum products underwater
- Current data for inland waters
- Techniques to test and maximize encounter rates at the bottom or in the water column

Other considerations discussed included:

- There are many new detection, containment and recovery technologies in different stages of development. How do we provide opportunities to test these products and then take them to the point where they are commercially available? Can grants, regulations, or technology competitions and prizes provide incentives? Are natural seeps viable targets for testing response technology? How can we require or manage new technologies requested and used during spills?
- Creation of a layer in NOAA's Environmental Response Management Application (ERMA) that identifies areas with the highest risk of NFO spills could be valuable and done in-house by OSPR.
- Washington State has reduced the USCG's required response time for Group V oil spills by 50 percent. Per regulation (173-182-324), resources for detection, containment, and recovery must be on-scene within 12 hours of spill notification. This timeframe also applies to crude oil and diluted bitumen. Washington also requires advance notice of all scheduled crude oil deliveries by rail car to be received by facilities, including API gravity. Is this something California should pursue?
- Legislative action in California could mandate a greater level of readiness (e.g., equipment staging requirements for OSROs) but should be considered in the context of the relatively low frequency risk of NFO spills. Because there aren't many NFOs produced in or shipped to the state, the risk of occurrence for NFO spills appears to be low.

PRESENTATION SUMMARIES

A video recording of the workshop, and copies of each presentation, can be found on the OSPR website: https://www.wildlife.ca.gov/OSPR/Public-Meetings/Technical-Advisory-Committee/Non-Floating-Oils

California Refinery Crude Oil Sources and Trends

Gordon Schremp, California Energy Commission (CEC)

NFOs are a subset of crude oil types used by California refiners.

Potential NFOs can include heated crude oil and heavy oils blended with diluents to reduce density.

California sources of crude oil continue to change with a number of trends:

- California and Alaska sourced oil continues to decline
- Foreign crude oil receipts increasing
- Initially growing rail receipts have declined

Crude-by-Rail (CBR) made possible by rapid increase in domestic oil production coupled with an inadequate spare capacity for pipeline movements:

- Rail transport of crude oil more expensive than pipeline movement
- Oil producers can shut-in production or sufficiently discount selling price to enable more-expensive rail transport option a viable alternative for refining customers
- Development of CBR receiving terminals in California has lagged other regions of the country due to local opposition
- Currently, less than 0.5 percent of crude oil received by refiners obtained by rail imports
- Washington state initiated CBR projects earlier than California and now receives up to 25 percent of crude oil via rail
- Canadian exports of crude oil via rail expected to rise next year

Crude oil data for NFOs is limited and after-the-fact:

- Information reported to the Energy Commission and Air Resources Board (ARB) is historical
- CEC does not see “type” of crude oil information by individual shipment
  - Source country, volume & delivery location for imports
  - Average density and sulfur content of monthly crude oil receipts by refiners
- ARB obtains crude oil “type” data on an annual basis from each refiner
  - Does not include density information
  - CEC analyzed data to identify potential NFOs
- Companies report monthly crude oil “type” data to the federal government, Energy Information Administration
  - CEC does not collect this information
  - Contains density information by individual shipment

Data Gaps:

- Crude oil “type” information collected by CEC & ARB does not allow for accurate identification and accounting of potential NFOs
- CEC does not receive route information from Class 1 railroads for crude oil shipments
- CEC does not receive advance notification for crude oil deliveries via marine or rail

Properties & Behaviors of Non-Floating Oils (NFOs)

Jordan Stout, NOAA's Emergency Response Division

Types of NFOs

Though most crude and refined oils float, some don't; either due to their inherent density or because their density changes via some weathering process (sedimentation or possibly evaporation). NFOs can either be submerged (suspended in the water column) or sunken (on the bottom). General NFO types:

- Oils that are heavier than water and mostly sink when spilled
- Oils that are lighter than water and sink after mixing with sediment (several examples)
- Oils that are lighter than water but become heavier as the lighter fractions are lost by evaporation (very few examples)

Important Oil Characteristics

Understanding an oil's **density** is clearly important, but so is the oil's **viscosity** and its **persistence**. While density affects where in the water column you may find the oil, its viscosity will affect the degree of physical dispersion and may affect interactions with sediment. Under the right conditions, floating oils that persist long enough may sink due to weathering processes (sedimentation, evaporation, etc).

Laboratory and field experience shows that most floating oils will not become denser than the receiving water due to evaporation alone. However, oils with a density close to that of the receiving water can become submerged in the water column under turbulent conditions. When this occurs, interaction with suspended or bottom sediments can cause oils to be heavier than receiving waters and sink in quiescent areas.

Diluted bitumen or "dilbit" is composed of about 70-80% bitumen (with very large, heavy molecules) and 20-30% diluent (with very small, light molecules that can evaporate easily). Other heavy oils typically have little if any light components at all, so we expect evaporation to have a more pronounced effect on dilbit density compared to other oils. Most of the increase in dilbit density caused by evaporation takes place in the first day or two.

Safety Data Sheets (SDSs) are too generic to be useful when planning for/responding to spills. Obtain chemical assay info from shipper (seller) or receiving facility (buyer). If a Canadian crude, then even the name of the crude will be more informative than an SDS for purposes of understanding the oil's characteristics & behavior in the environment. Low tech (benchtop) option… Command Post science demo: place a source sample into some receiving water and see what happens.

Important Receiving Water Characteristics

Seawater (°API = 6-7) is denser than freshwater (°API = 10), so know the **density** of the receiving waters. Also, understanding the local **currents/turbulence** and potential for **oil interaction with sediments** (turbidity, shoreline/bottom interactions) will also be important, particularly with floating, persistent oils.

Considerations & Potential Data Gaps

- Getting good info on oil and receiving water characteristics quickly can be critical
- Does evaporation substantially affect densities of most/all dilbits?

NFO Trajectory Analysis: Tools and Data Gaps

Christopher H. Barker, NOAA's Emergency Response Division

Guidelines for modeling

What is Modeling?
There are many models, from the very simple to the complex.

What questions are you trying to answer?
You need to know the questions that you are trying to answer in order to select and apply an appropriate model.
The model selected should be as simple as possible to answer the questions at hand.

What processes does the model capture?
What processes are most important in the particular case? A given model only captures some processes -- does it capture the ones relevant to the problem at hand.

What inputs do we need?
All models require a lot of input data:

- Information about the release -- where, when, how much
- Information about the product -- physical and chemical properties
- Information about the environment: Winds, Currents, Water Properties, Sediment Properties...

What is the Uncertainty?
Uncertainty in the results comes from both errors in the model, missing processes, and uncertainty in the inputs.

Processes to Model

Fate and Transport -- primary response question
Where is the oil going to go? How are its properties changing with time? These are interrelated.

Impacts to the Environment -- more about injury assessment
Requires much more detail -- both of fate and transport, and presence of biota

Challenges of Non-Floating Oil -- with case studies

- More sensitive to some physical properties: density, viscosity
- You can't see it! -- calibration is hard
- Mobilization -- not well understood
- Physical properties less understood -- "slurry oil"

Aquatic Resources at Risk from NFO Spills

(Water Column and Benthic Organisms)

Kathleen Jennings, CDFW- OSPR

Because most petroleum floats, traditional oil spill response focuses on identification of resources at risk in surface waters. For non-floating oils (NFOs), resources at risk include organisms within the water column and benthic (bottom-dwelling) organisms, for both marine and freshwater ecosystems.

Marine Food Web – Because organisms within an ecosystem are interrelated, water column and benthic resources can be directly or indirectly at risk from NFO spills. Marine examples include:

- Marine Water Column Species
- Marine Benthic Fish Species
- Marine Benthic Invertebrates

Freshwater Food Web – Similarly, organisms within a freshwater food web can be directly or indirectly at risk from NFO Spills. Freshwater examples include:

- Riffles and Pools
- Salmon Redds
- Fresh Water Column Species
- Freshwater Benthic Invertebrates
- Benthic Macroinvertebrates
- Freshwater Benthic Macroinvertebrates
- Sensitivity of Benthic Macroinvertebrates

As with traditional oil spill cleanup, resources can be at risk from the oil itself, or from the cleanup. For NFOs, the cleanup is typically more challenging because it needs to occur at the bottom of the waterbody where the oil is found, with limited access, visibility, and use of specialized and potentially damaging equipment. As a result, impacts from cleanup of NFOs can represent a substantial threat to water column and benthic organisms.

Non-Floating Oil Effects on Natural Resources

April DaSilva, CDFW-OSPR

Group 4 and Group 5 oils may behave as non-floating oils due to their physical-chemical properties and the environmental conditions in which they are released. Submerged/sunken oil may reside longer in the sediments due to slow weathering, its density, and viscosity. Laboratory and field studies have shown exposure to this oil type results in adverse effects on benthic macroinvertebrates and fish.

Adverse effects include:

- Reduction in benthic communities due to contaminated sediments
- Physical malformations on bottom dwelling fish, including skin lesions, tumors, hemorrhages and developmental defects
- Reduction in food supply and feeding capabilities
- Reduction in growth, reproduction, and development
- Mortality

Submerged and sunken oils may have various effects on both freshwater and marine ecosystems such as:

- Bottom-up effects – abundance of lower trophic level organisms shift.
- Top-down effects – biomass in the upper trophic levels (i.e., predators) is enhanced.

Suspended Oil Containment/Protection Techniques

Kurt Hansen, US Coast Guard, Research & Development Center

The techniques for submerged oil detection and recovery in specific conditions include:

- Limited use of sonar
- Limited use of nets
- Limited use of sorbents
- Limited use or air

Sonar maybe useful in higher concentrations or if oil is suspended with air or sediments

Trawls and nets are very inefficient, with high potential for leakage with low to moderate viscosity oils, have little possibility for reuse, and can snag on debris, marine life, rocks, and other obstructions.

Sorbents may be used for removal of small amounts and droplets of oil but efficacy is unknown.

There are a couple of methods for agitation/refloat. However, this technology is slow, labor intensive, can release suspended oil and turbidity for deposition down current that is difficult to contain, and is limited to shallow water.

Expect that almost options will collect a large amount of water that will need to be processed so waste stream treatment need to be better planned.

Data Gaps:

- Defining issues of oil droplets versus dissolved oil recovery
- No practical approaches
- Sorbent Efficacy still unknown in currents
- How to Test new approaches

Sunken Oil Containment/Protection Techniques and Data Gaps

Jacqueline Michel, Research Planning, Inc.

The proven and promising techniques for sunken oil recovery include:

- Suction Dredge
- Diver-Directed Pumping and Vacuuming
- Mechanical Removal
- Sorbent/V-SORs
- Trawls and Nets
- Manual Removal
- Agitation/Refloat

Dredging and pumping/vacuuming generates large volumes of oil, water, and sediment for handling, treatment, and disposal. Space for such operations can be limiting.

Mechanical removal generates less waste materials. Excavators are not selective, generating excessive clean sediment, and can have leakage during lift. Existing technology for environmental clamshell excavation allows tracking of each "bite" for documentation and effective removal.

Sorbents can be used for removal of trace amounts of oil, as a final polishing step.

Trawls and nets are very inefficient, with high potential for leakage with low to moderate viscosity oils, have little possibility for reuse, and can snag on debris, rocks, and other obstructions.

There are many methods for agitation/refloat. However, this technology is slow, labor intensive, disturbs the substrate and biota, can mix oil deeper into the sediment, can release suspended oil and turbidity for deposition down current that is difficult to contain, and is limited to shallow water. Careful consideration of these limitations and testing at the spill site are needed before implementation should be considered.

Techniques for waste stream treatment need to be better planned; oftentimes, methods are ad hoc and inefficient.

Data Gaps:

- Optimization of nozzle and stinger designs to minimize water and sediment removal during vacuuming and pumping operations
- Evaluate the performance of wastewater treatment systems for effluents typical in content and variability from sunken oil recovery operations–including offshore conditions

USCG Regs for Group V Oils and OSRO Classification for NFOs

Mark Gregory, USCG D11 District Response Advisory Team (DRAT)

The regulations for Group V oils for facilities and vessels are very similar. Highlighting some of the similarities and a few of the subtle differences will intentionally generate some questions.

33 CFR 154.1047(a)(1) and 33 CFR 155.1052(a)(1) state that plan holders must identify procedures and strategies for responding to a WCD of Group V petroleum oils to the maximum extent practicable.

Both facility and vessel regulations require the plan holder take in to account operating conditions such as, Ice conditions, Debris, Temperature ranges and Weather-related visibility.

The regulations separate core resources into Detection, Containment, and Recovery Capabilities that impact assessment and other appropriate equipment.

There are some differences in wording for response times between facilities and vessels.

33 CFR 154.1047 (d) Response resources identified in a response plan for a facility that handles, stores, or transports Group V petroleum oils under paragraph (c) of this section must be capable of being at the spill site within 24 hours of discovery of a discharge.

33 CFR 155.1052 (d) Response resources identified in a response plan under paragraph (c) of this section must be capable of being deployed within 24 hours of discovery of a discharge to the port nearest the area where the vessel is operating.

Guidelines for the U.S. Coast Guard Oil Spill Removal Organization Classification Program March 2016

- In the March 2016, the new OSRO Guidelines included Chapter 6. OSRO Classification Guidelines for Nonfloating Oils.
- Heavy oils and Group V oils were merged and defined as “nonfloating oils.”
- Plan holders that handle, store or transport oils that are not Group V oils, but fall under the nonfloating oil definition, are highly recommended to resource nonfloating oil classified OSRO’s in addition to OSRO’s already classified in the Mechanical classification program.
- Plan holders that handle, store or transport oils that are Group V oils shall utilize nonfloating oil classified OSRO’s.
- Resources counted for OSRO classification can be owned or contracted.
- Eleven OSROs have received a nonfloating oil OSRO Classification, six in CA.
- Submitted requests were reviewed by CG District SMEs, NOAA SSC and CG HQ.
- Future plans are to complete Preparedness Assessment Visits and conduct NFO GIUEs, which the latter will provide challenges in planning and completing.

Non-Floating Oil Detection and Recovery

Jim Elliott, Vice President of T&T Marine Salvage

Abstract: In 2016, following a number of submerged and sunken oil incidents, the U.S. Coast Guard issued revised Oil Spill Removal Organization Guidelines that include the requirement for the detection and recovery of non-floating oils. Oil spill response companies desiring Coast Guard approval to respond to non-floating oils must now first submit a concept of operation and also undergo a governmental company review and audit program.

This presentation will discuss the new Coast Guard rules and the innovative new procedures discovered in preparing a concept of operation to meet these standards. Non-floating oil detection options will include side-scan and multi-beam sonar, laser fluorosensors, sub-bottom profilers, commercial divers, remotely operated vehicles, and traditional towed sorbents. Recovery techniques will include specialized dredges and environmental clamshells, diver and ROV-directed pumping systems, specially designed trawls and nets, and other specialized mechanical recovery systems. In addition to detection and recovery, the presentation will address the logistical and operational requirements to meet the Coast Guard response timelines, the issues of storage and waste stream treatment, and the unique challenges of deep water operations.

Biography: Jim Elliott, Vice President of T&T Marine Salvage, is responsible for managing worldwide marine salvage, heavy lift, commercial diving and emergency response operations. A retired senior Coast Guard officer with over 25 years of experience managing search and rescue, marine casualty and pollution response operations, Jim has numerous advanced qualifications, including the highest US Incident Commander certification, Master Diver, Federal On-Scene Coordinator and National Strike Force Response Officer certifications. He holds a Bachelor of Science in Environment Management, a Master of Environmental Policy with honors, and a Master of Arts in National Security and Strategic Studies with highest distinction from the U.S. Naval War College. Jim also currently serves as Vice President of the American Salvage Association.

Mr. Elliott served as an author of the American Petroleum Institute (API) Report and Operations Guide on Submerged Oil Detection and Recovery that serves as the foundational document for the Coast Guard's non-floating oil detection and recovery policies. Additionally, he has served in key leadership roles on multiple non-floating oil response operations, including the *ARGO, ATHOS I, DBL-152, BOW MARINER*, and *DEEPWATER HORIZON*, among others.