Module 6: Oil Spill Management and Response Options

SETAC Orlando 2017 Short Course
"Oil in the Aquatic Environment: Sources,
Fate, Effects, Monitoring and Response Options"
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Lead Instruction: Tim Nedwed, ExxonMobil
Upstream Research Company,
tim.j.nedwed@exxonmobil.com

Objectives

- Oil spill response tactics
- Response challenges
- Resources at Risk
- Response decision making

Outline

- Background
  - Priorities: human health → environmental protection
  - No response options ruled out in advance
  - Decisions based on Net Environmental Benefit Analysis (NEBA)
  - Tiered response
  - Contingency planning / drills / Oil Spill Response Organizations
- Response complexities
  - Weather
  - Logistics
  - Slick dynamics: spreading / break up / emulsification /evaporation / etc.
- Resources at Risk / Potential Impacts / Exposure-Receptor pathways
  - Shorelines
  - Water column
  - Wildlife (i.e., marine mammals, birds, species under the Endangered Species Act)
- Response Options
  - No response options ruled out in advance
  - Containment and mechanical recovery
  - In-situ burning
  - Dispersants: surface / subsea
  - Shoreline protection strategies / monitoring / clean-up
- Environmental Monitoring of Oil Spills
  - Slick monitoring / remote sensing; Shoreline monitoring (SCAT)

Background

Priorities: human health → environmental protection

Safeguard People

Protect the Environment

Background

The goal is to design a response strategy based on *Net Environmental Benefit Analysis (NEBA) aka Spill Impact Mitigation Assessment (SIMA)*

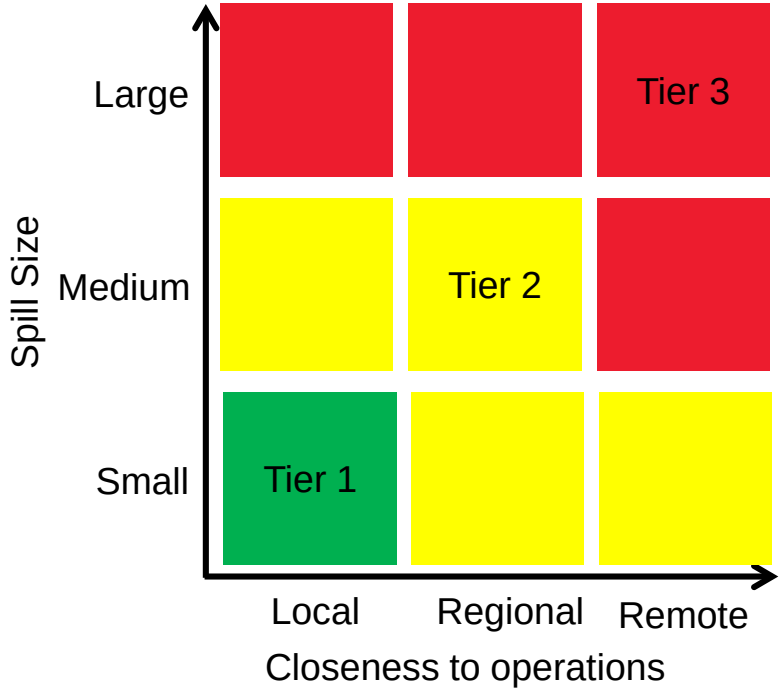
"Structured approach used by the response community and stakeholders during oil spill preparedness planning and response, to compare the trade offs of potential response tools, and develop a response strategy that will reduce the impact of an oil spill on the environment"

Helps decision-makers use the response tools to achieve the most beneficial outcome overall

Background

Three Tiered Response Approach

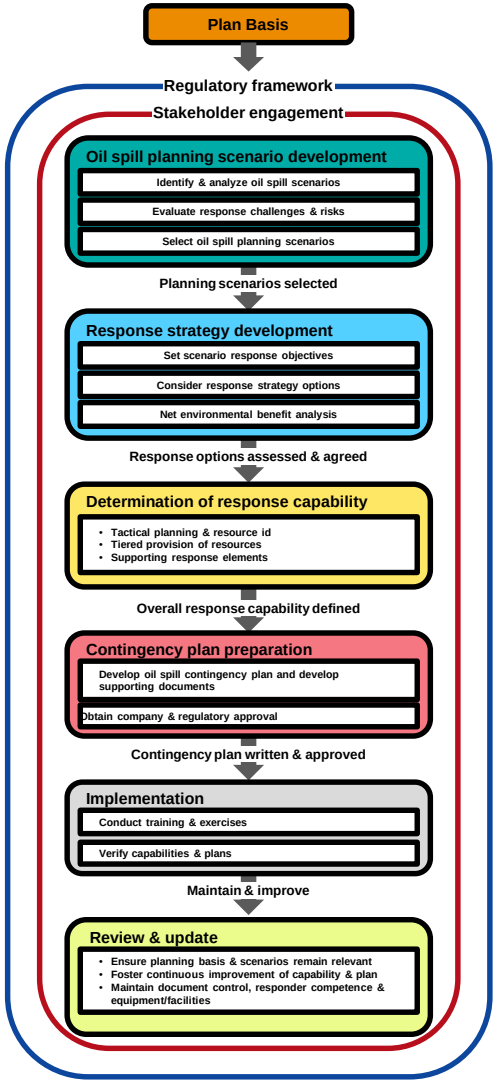
- Tier 1 spill: Accidental discharges occurring at or near a facility as a result of routine operations. Impacts are low and in-house capability is adequate
- Tier 2 spill: Medium-sized spills occurring within the vicinity of a facility as a consequence of a non-routine event. Significant impacts are possible and external (regional) support for adequate spill response is required
- Tier 3 spill: Large spills occurring either near or remote from a facility as a result of non-routine event, and requiring substantial resources and support from National or International spill cooperatives to mitigate effects perceived to be of national or international significance.



Background

Contingency Planning

- Structured process
  - Oil spill scenarios defined
  - Response strategy developed
  - Response equipment defined
- Used to guide response actions



Background

Continuous Improvement with Drills and Training

Oil Spill Response Organizations

International

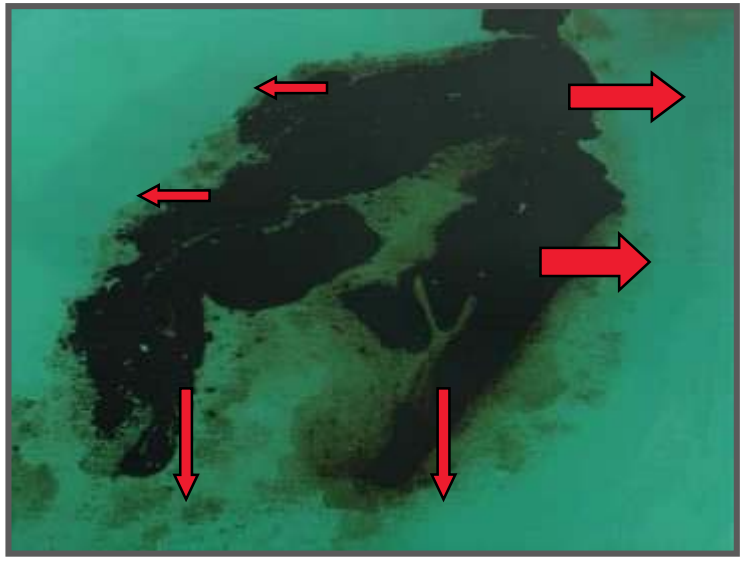
- Austria
- USA
- Holland
- Malaysia
- Canada
- Norway
- France
- Germany
- Japan
- United Kingdom

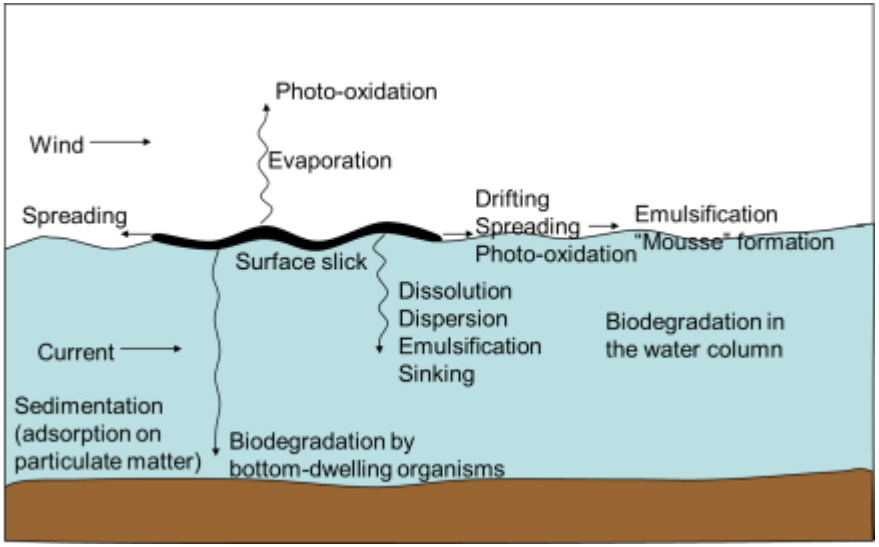
Response Complexities

- **Weather**
  - **Recovery impossible in rough seas or high winds**
  - **Unsafe in very high seas**
- **Thousands of Different Crudes**
  - **Wide range of properties**
- **Remote Locations**
  - **No immediate logistical support**
- **Wide Range of Impacted Habitats**
  - **Rock beaches to sensitive marshes**
- **Very Little Daylight During Winter at Some Latitudes**

Response Complexities

- **Spilled oil is very dynamic**
  - **Slick spreading / thinning / breaking apart**
  - **Oil weathering: evaporation / emulsification / dissolution**





Response Options Get Less Efficient With Time

Resources at Risk

- Water column
  - Potential exposure of organisms to dissolved and dispersed oil present
  - May be less severe and long-lasting
    + Dispersed & dissolved oil dilutes in three dimensions
    + Organisms have reproductive schemes developed for speed and high loss
    + Water column constantly moving
  - Commercial / recreational fishing can be disrupted
  - Risk drivers are the volume of the water column, magnitude of oil concentrations, duration of exposure

Resources at Risk

- Surface oil
  - Potential exposure to wildlife and socio-economic features
  - Exposure pathways
    - Direct oiling of birds, marine mammals, & turtles
    - Uptake of dissolved & dispersed oil
    - Inhalation of volatiles (including response workers)
  - May be more severe than water column
    + Oil dilutes in only two dimensions
    + Many surface dwelling organisms have slower reproductive schemes
    + Thick patches of surface oil can persist for longer periods – days to perhaps weeks
  - Recreation & tourism can be disrupted
  - Risk drivers are the size, movement, and persistence of the slick

Resources at Risk

- Shoreline / near shore oil
  - Potential exposure to wildlife and socio-economic features
  - Exposure pathways
    + Direct oiling of birds, marine mammals, & turtles
    + Uptake of dissolved hydrocarbons in near shore water
  - May contain higher concentrations of organisms
    + Oil concentrates in primarily one dimension
    + Oiled locations are fixed
    + Biodensity can be high in many near shore areas
    + Near shore areas are the nursery for organisms important to the marine food web
    + Shoreline / near shore habitats can have some of the longest relative recovery times
  - Recreation & tourism can be disrupted
  - Risk drivers are the size, movement, and persistence of the oil in nearshore/shoreline sediments

Response Options

All Tools in the Toolbox

Mechanical Recovery: Booms & Skimmers

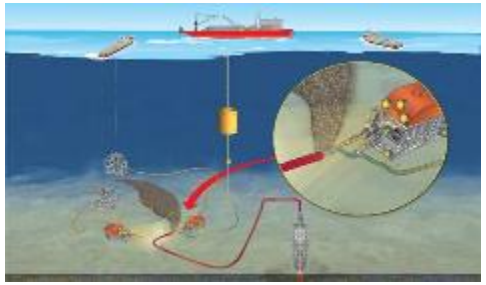
In-Situ Burning

Monitor & Evaluate

Aerial

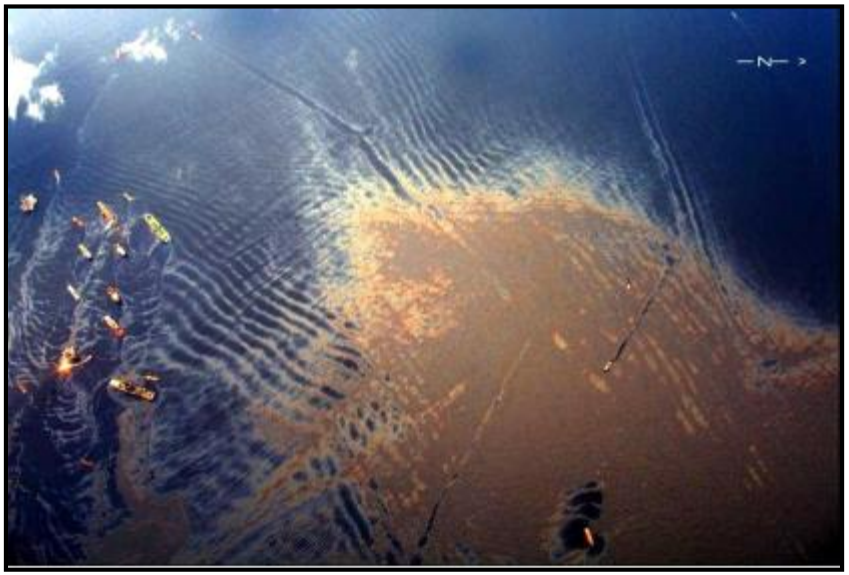
Dispersants Vessel

Subsea



Response Options

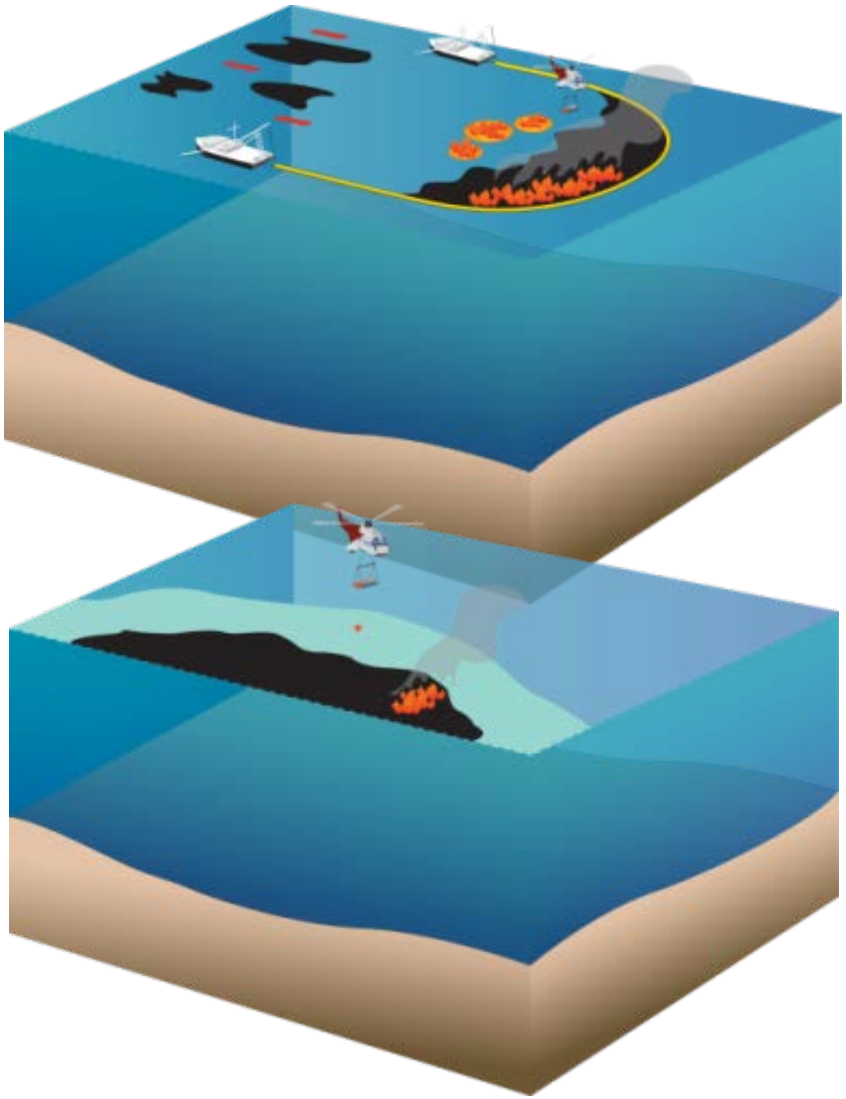
- Mechanical recovery using booms and skimmers
  - Will always be an important response option
    - + Takes oil out of the environment
    - + Vast majority of spills are small
  - Challenged by large offshore spills
    - + Limited encounter rates
    - + Sea states constraints
    - + Significant logistic requirements



Speed is key to offshore oil spill response

Response Options

- *In situ* burning using fire-resistant booms or herding agents
  - Advantages
    + Removes oil from marine environment
    + Destroys toxic components leaving recalcitrant residue
    + Limits oils storage & handling
  - Challenges for fire-resistant booms
    + Limited encounter rates
    + Sea state constraints
    + Significant logistic requirements
  - Herding agents
    + Allows *in situ* burning by aircraft

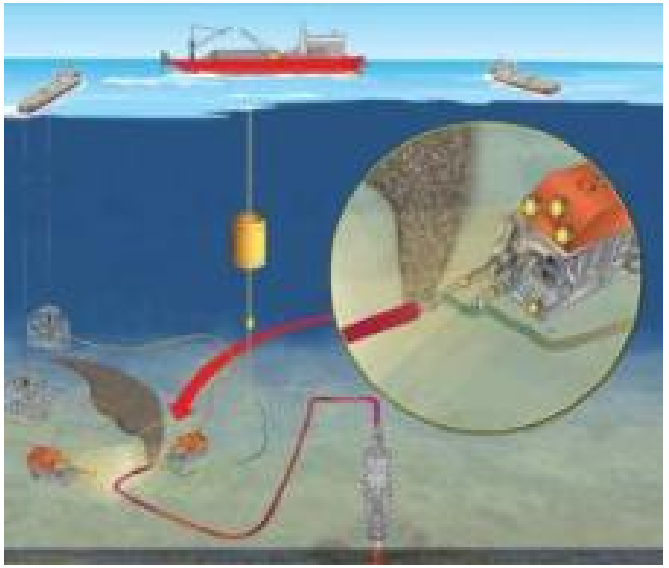


Response Options

- Dispersants
  - What are they?
    + Dispersants are solutions of surfactants that reduce oil-water interfacial tension
    + Dispersed oil rapidly dilutes
    + Each dispersed oil droplet is a concentrated microbial food source
    + Dilution enables efficient aerobic biodegradation
  - Modern dispersants use ingredients found in household products
    + Dispersant toxicity < toxicity of most oils
  - Advantages of Surface Dispersant
    + Allows response at the speed of aircraft
    + Allows treatment at the release point
    + Larger weather window than other options
    + Effective dispersant use can remove oil from the environment in days to a few weeks
  - Challenges
    + Trades more oil on the sea surface for more oil in the water column
    + Window of opportunity can be small

Response Options

- Subsea Dispersants
  - What are they?
    - Dispersant applied directly at the source of a well-control event subsea
  - Advantages
    - Immediate response at release point
    - Treats fresh oil at the energetic source – potentially treats all the oil
    - Applied day and night
    - Exposure to VOCs by well-control responders may be reduced
  - Challenges
    - Trades more oil on the sea surface for more oil in the water column



Environmental Monitoring of Oil Spills

- Remote Sensing
  - Improves effectiveness of offshore response
  - Airborne sensing provides additional benefits
  - Common airborne sensors are personnel, video/cameras, IR, UV, and SLAR
  - Key needs
    + Accurate slick thickness
    + Night time observations
    + Real-time data
    + Portability

Summary of Key Messages

- Spill prevention is the priority
- All response options should be available
- Mechanical recovery will always be most widely used option
- Response strategy based on NEBA
- Speed is the key to offshore oil spill response